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Signal Strength and Residual Energy Based Route Selection in MANET

Manisha Mandal[1], Prasant Richariya[2]
Department of Computer Science and Engineering
TIT Advance, RGPV, Bhopal, India
[1]svpslmanisha@gmail.com, [2]prashant1579@gmail.com

Abstract— *Energy-efficient routing is one of the important issues in Mobile Ad hoc Network. The Mobile nodes in this temporary network are forming the limited-time link establishment to neighbours. The nodes freely move in a surrounding area for sensing the neighbours to deliver the data in the network. The transmission of data through the sender highly consumes the energy in MANET, and this energy is neither possible to gain again nor possible to replace batteries. The energy or battery power of nodes is limited because efficient consumption is needed to improve node and network lifetime.*

In general, a node in a MANET suffers from connectivity instability because of channel quality variation and limited battery lifespan. Therefore, an efficient algorithm for controlling the communication links among nodes is essential for constructing a MANET. This paper proposes a Signal Strength & Residual Energy (SSRE) energy-efficient route selection routing scheme to simultaneously increase energy efficiency and network connectivity. The proposed algorithm always selects the neighbour nodes that have the highest energy among all neighbour nodes. The intermediate nodes are easily exhausting their energy due to accepting and forwarding data in a dynamic network. The proposed scheme is utilised these nodes energy by selecting them according to higher RSS energy level. The sender has received the reply from each request and decided the higher energy node for data sending. The proposed energy-efficient scheme improves network performance as compared to normal shortest path routing. The routing performance is evaluated through performance metrics like routing overhead, throughput and delay.

Keywords: - Energy, MANET, Routing, RSS, Routing performance, RRSE.

I.INTRODUCTION

MANETs are self-organised networks whose nodes are free to move randomly while communicating with each other without the help of an existing network infrastructure. MANETs are suitable for any wired or wireless infrastructure inaccessible, overloaded, damaged or destroyed, such as emergency or rescue missions, disaster relief efforts, tactical battlefields and civilian MANET situations, such as conferences and classrooms in the research area like sensor networks. MANETs eliminate this dependence on a fixed network infrastructure where each station acts as an intermediate switch. Mobile hosts and wireless networking hardware [1, 2] are becoming widely available, and extensive work has been done recently in integrating these elements into traditional networks such as the Internet. Frequently, mobile users want to communicate where no fixed wired infrastructure is available, either because it may not be economically practical or physically possible to provide the necessary infrastructure or because the situation's expediency does not permit its installation.

Fig 1. Mobile Ad hoc Network

Figure 1 represents the mobile ad hoc network. Nodes within an ad hoc network generally rely on batteries (or exhaustive energy sources) for power. Since these energy sources have a limited lifetime, power availability is one of the most important constraints for the ad hoc network's operation.

For example, in a class of students who can need to interact during a lecture, friends or business associates may run into each other in an airport terminal and wish to share files, or a group of emergency rescue workers may need to be quickly deployed after an earthquake or flood. In such situations, a collection of mobile nodes with wireless network interfaces can form a temporary network without the support of any established infrastructure or centralised administration. This type of wireless network is known as an ad hoc network.

There are different energy sources or energy [2, 3, 4] in a mobile ad hoc network. Communication is one of the main sources of energy consumption. Since the rate of battery performance improvement is rather slow currently, and in the absence of breakthroughs in this field, other measures have to be taken to achieve the goal of getting more performance out of the currently available battery resources.

Wireless networks are proposed to overcome wired backbone networks' restrictions, which provide mobile users with ubiquitous communication capability and Information access regardless of their locations. The flexibility and mobility the wireless networks make them the network of choice. There are two categories of wireless networks, i.e., infrastructure-based wireless networks and wireless ad hoc networks. An ad hoc wireless network is designed to overcome the natural limitation of wired backbone networks and infrastructure-based wireless networks. The network comprises mobile nodes sharing a wireless channel and dynamically forming a temporary network topology without network infrastructure or centralised administration.

The topology of the network changes frequently and unpredictably since its host moves randomly. Therefore, routing is an integral part of ad hoc communication and has received interests from many researchers. In traditional "on-demand" routing schemes like Ad Hoc On

Demand Distance Vector Routing (AODV) scheme [4], when route disconnects, nodes of the broken route simply drop data packets because no alternate path to the destination is available until a new route is established. When the network traffic requires real-time delivery (voice, for instance), dropping data packets at the intermediate nodes can be costly. The Power-aware scheme in Ad hoc routing Protocol enables dynamic, self-starting, multi-hop routing between participating mobile nodes wishing to establish and maintain an ad hoc network. It allows mobile nodes to maintain routes to destinations with more stable route selection. This scheme responds to link breakages and changes in network topology promptly and takes care of nodes that do not have better power status to participate in route selection. One distinguishing feature of the Power-aware ad hoc routing scheme is its power status for each route entry. The available option between two routes to a destination requires a requesting node to select one with better power status and more active.

Communication is one of the main sources of energy consumption. Since the rate of battery performance improvement is rather slow currently, and in the absence of breakthroughs in this field, other measures have to be taken to achieve the goal of getting more performance out of the currently available battery resources. The proposed energy-efficient AODV routing protocol techniques can perform well in energy conservation to achieve that, neighbourhood energy knowledge at nodes is required. In energy, information is decided which path is selected for data sending—the proposed algorithm results in unbiased energy spending among the nodes, which maximises the network lifespan. When given multiple paths to choose from during the routing process, choose the path to prolong the network lifetime.

II.PREVIOUS WORK

The previous works that were done in this field are mentioned in this section. Several energy-efficient techniques are proposed to reduce energy consumption in MANET. These techniques use energy-aware metrics to establish a path in a network. These metrics are residual energy, transmission power or link distance.

Peyman Arebi in [6] proposed a novel method based on energy estimation to restore broken links and reconstruct their paths to investigate the effect of broken links on topology control and routing process in the Ad-Hoc network. It indicated that these effects were harmful in the mentioned couple of network portions. The author used Hardware Method for energy estimation in the ad-hoc nodes. This method has a high speed and finally finds out the effect of link break on the ad-hoc network. One may find out that both routing algorithms and topology control negatively affected, and, in some cases, the entire network is a disorder. These effects may cause some serious problems in data transferring and the efficiency of different network parts. For this purpose, a strategy was made to prevent link break and disordering. This strategy could give some suggestions to route the network through prediction and time estimation of the link break.

Ashwani Kush, Sunil Taneja and Divya Sharma in [12] had been proposed that work on a reactive approach and utilised alternate paths by satisfying a set of energy and distance-based threshold criteria. The scheme incorporated into any ad hoc on-demand routing protocol to reduce frequent route discoveries. Alternate routes are utilised when data cannot deliver through the primary route. As a case study, the proposed scheme was applied to AODV, and a significant performance improvement was observed compared to DSR. Simulation results indicated that the proposed scheme provides robustness to mobility and AODV protocol performance. The average increase in packet delivery occurs for different network scenarios. The scheme performs better in the denser medium as mode nodes are available for better selection.

Mansoor-uz-Zafar Dawood, Noor Zaman, Abdul Raouf Khan, Mohammad Salih in [13] provide an effort to design an energy-efficient Wireless Sensor Network (WSN) routing protocol, under certain parameters consideration. The research report discusses various existing WSN routing protocols and proposes a new Location Aware (L.A.) WSN energy-efficient routing protocol and finally has been proposed a new Location-Aware LA WSN protocol and results show a great improvement in energy enhancement and WSN life cycle.

Nicola Costagliola et al. [14] discussed the M-channel group communication middleware for Mobile Ad-hoc Networks to let it become both delays- and energy-aware. M-channel makes use of the Optimised Link State Routing (OLSR) protocol, which is natively based on a simple hop-count metric for the route selection process exploits Dijkstra's algorithm to find optimal paths across the network. It added a new module to the MChannel for enabling unicast routing based on two alternative metrics, namely end-to-end delay overall network lifetime. With such a new module, we prove that network lifetime and average end-to-end delay improves compared to the original OLSR protocol. This implementation was included in the mentioned middleware and finally evaluated and proposed two extensions of the OLSR protocol to consider the mentioned metrics.

Sofy Harold and A. Vija Y Alakshmi proposed in [15] a new reliable protocol called Enhanced Power Control MAC Protocol for Wireless Ad-Hoc Networks (EPCMAC). The key concept of this EPCMAC protocol is to improve the throughput and save energy by sending all the packets with optimal transmit power. This communication approach promises improved throughput and delay performance by using spatial diversity in wireless ad hoc networks. The data packets' power is periodically raised to a suitable level but not to the maximum to avoid interference and unnecessary contention between nodes.

Mohammad A. Mikki in [16] introduces an Energy Efficient Location Aided Routing (EELAR) Protocol for MANETs that is based on the Location Aided Routing (LAR). EELAR makes a significant reduction in the mobile nodes' energy consumption by limiting the discovery of a new route to a smaller zone. Thus, control packets overhead are significantly reduced. To show the efficiency of the proposed protocol, we present simulations using NS-2. Simulation results show that the EELAR protocol improves control packet overhead and delivery ratio compared to AODV, LAR, and DSR protocols. The conclusion of an Energy Efficient Location Aided Routing Protocol (EELAR) optimises the Location Aided Routing (LAR). EELAR makes a significant reduction in the mobile nodes' energy consumption by limiting the discovery of a new route to a smaller zone. Thus, control packets overhead are significantly reduced, and the mobile nodes lifetime is increased.

Wei Liu, Chi Zhang, Guoliang Yao and Yuguang Fang in [17] introduce the addresses energy conservation, a fundamental issue of paramount importance in heterogeneous mobile ad hoc networks (MANETs) consisting of powerful nodes (i.e., P-nodes) as well as normal nodes (i.e., B-nodes). By utilising the inherent device heterogeneity, we propose a cross-layer designed Device-Energy-Load Aware Relying framework, named *DELAR*, to achieve energy conservation from multiple facets, including power-aware routing, transmission scheduling and power control and present a multi-packet transmission scheme to improve the end-to-end delay performance.

Nini Wei, Yi Song in [18] introduce a new energy-aware routing policy based on dynamic priority factor named EDSR for ad hoc is proposed, which is based on the classic DSR (the routing protocol on demand). Simulation with the NS2 then compared with the on-demand routing DSR from the energy-consuming and the number of remaining nodes, the performance superior to the traditional DSR protocol. The EDSR routing, which spends less energy and larger link capacity, is synthetically analysed and then selected to save more energy and delay the network split. The EDSR routing, which spends less energy and larger link capacity, is synthetically analysed and then selected to save more energy and delay the network split.

Authors [19, 27] proposed an energy-efficient routing protocol (EERP) balances node energy utilisation to reduce energy consumption and increase nodes' lives, thus increasing the network lifetime, reducing the routing delay and increasing the reliability of the packets reaching the destination. Wireless networks do not have any fixed communication infrastructure. For an active connection, the end host and the intermediate nodes can be mobile. Therefore, routes are subject to frequent disconnection. It is important to minimise disruptions caused by changing topology for applications using voice and video in such an environment. Power-Aware routing enables the nodes to detect misbehaviour like a deviation from regular routing. It is forwarding by observing the node's status by exploiting non-random behaviours for the mobility patterns that the mobile user exhibits network topology can be predicted and perform route reconstruction proactively promptly. This paper proposed an Energy-Efficient- Power-Aware routing algorithm where we have integrated energy efficiency with power awareness parameters for routing of packets.

S V. Rishiwal et al. [20] proposed a Power-aware routing that maximises the network lifetime and minimises the power consumption by selecting a less congested and more stable route source-destination. The route establishment process to transfer real-time and non-real-time traffic, hence providing energy-efficient routes. PAR focuses on three parameters: Accumulated energy of a path, battery lifetime status, and type of data to be transferred. PAR focuses on its core metrics like traffic level on the path, battery status of the path, and request type from the user side at the time route selection. With these consideration factors, PAR always selects less congested and more stable routes for data delivery provides different routes for a different type of data transfer. It increases the network lifetime. The Simulation results show that PAR outperforms similar protocols such as DSR and AODV, with respects to different energy-related performance metrics, even in high mobility scenarios. Although PAR can somewhat incur increased latency during data transfer, it discovers routed to last for a long time and encounters significant power saving.

Jailani Kadir et al. [21] define a method for identifying the intermediate node with optimum stored energy that could withstand through the connection duration. This algorithm tested with simulations and proved that the node with the largest probability consumes the lowest energy. It not only helps to sustain the communication with the lowest chance of interruption but also prolongs the network lifetime due to the lowest possible consumption of energy for a given communication

III.PROPOSED APPROACH

(i)Proposed Signal Strength & Residual Energy (SSRE)

Favourable, established routes are consisting of many short hops, which more energy-efficient than long hops. However, when the processing power is considered, routes consisting of many short hops are no longer energy-efficient. At each hop, a fixed amount of energy is consumed by processing elements. The nodes that gradually lose their energy in a network are dangerous because, without any information, these kinds of nodes go to sleep mode. In this research, we proposed the Signal Strength & Residual Energy (SSRE) Algorithm to minimise mobile nodes' energy consumption in MANET. Every node's operation requires energy or power, and a limited capacity battery source provides this power.

The nodes are moves freely, and every time instance, the topology in the network changes. The sender/s is establishing the connection with receiver/s through intermediate nodes. In a particular network number of senders are trying to send their data to the receiver. Nearly all data was received at the destination, but link failure, initial energy loss, and Nodus went out of range without confirmation, causing some data to drop. By default, it selects the shortest path for sending data in the network, and the receiver is receiving data. In this communication procedure, intermediate nodes play a very important role because they receive data from the neighbour's sender and forward that data to the next node or destination. Each communication procedure requires some energy, and for successful data delivery, the following steps are required: -

1. Sender sense the neighbour for forwarding Route Request (RREQ). The energy is required for sending is called Sense energy.
2. The sender sends RREQ, and the neighbour receiving that RREQ replies (RREP) route replies that also required energy for sending and energy for receiving.
3. Suppose the nodes are not taking participation in routing in an idle state. It implies that it also consumes energy but equal to negligible called Idle energy.
4. The nodes in networks that cannot participate in routing or deplete their energy completely are going to sleep mode. The sleep mode is also required a negligible amount of energy.

Transmission Energy (Tx) is the highest consumption source of energy. After that, the receiver is consumed the highest energy for data received, i.e., Receiving Energy (Rx). In rest of the energy consumption parameters like Sense Energy Consumption, Idle Energy Consumption, Sleep Energy Consumption is required negligible energy. Every successful, efficient communication is also continuously depleting the energy of mobile nodes. The sender is frequently selecting the same node for data delivery. This node is exhausted their energy early, and if their energy is finish in the time of data delivery causes heavy packet dropping. The higher RSS in the proposed scheme utilises mobile nodes' energy consumption and improves data delivery reliability.

The proposed scheme is the Energy Efficient depletion routing scheme deals with the utilisation of energy resources. Some little issues and solutions witness energy-efficient routing in ad hoc wireless networks. This work uses the maximum energy concept to remove the "sudden loss of session" and do the energy-efficient routing. Suppose any nodes in the network have a value smaller or equal to the threshold value. In that case, they cannot participate in communication and calculate the average energy of all possible paths and select the path with the maximum average energy level. By controlling the early depletion of the battery, adjust the energy to decide the proper energy level of a node and integrate the low power strategies into the protocols used in various protocol stack layers. The proposed solution improves the:

- Maximises energy utilisation.
- Reduces packet loss.
- Reduces routing load.

(ii) Proposed Algorithm for MAX energy base Route Selection

Create a mobile node = N
Set routing protocol = AODV // **for Routing Protocol**
Number of Mobile Nodes = N_n
Set of Intermediate mobile node's = $N_{.I.}$, // N_{Ii} and N_{Ik} Є $N_{.I.}$
Set sender Node = N_s; **// N_s Є N**
Set Destination Node = N_d **// N_d Є N**
Initialise N.R. (Node_Range) = 550m; // the range of mobile nodes communicate with each other in this range measured in meters.
Set MAC = 802.11 // for Media access control
Set initial energy of each node (E_n) = {E_1, E_2, E_3 of nodes N_1, N_2, N_3}
Step1: Route Established (Sender, Destination, E_n, Node_Range)
Step2: {if (Node_Radio_Range <= 550 && next hop count! = Destination && E_n > 0)
Step3: While (path exist in between Source, Intermediate (N_I) && N_I != N_d) // check the possibility of destination
{Broadcast routing packets to next neighbour
Increment hop count value of Sender including N_i
}
Step4: If (N_I == N_d (Destination)) // Compare the Intermediate
node is a destination node
{Maintain routing table of N_d Destination Node
Create energy table of nodes N_s-N_I-N_d
Reply to Sender (N_s)}
Step5: If (Path Established is >1) // for identified high RSS energy
path
Step6: {if (path N_{Ii} from S to D && path N_{Ik} from S to D) // Check two paths reliability

{Construct routing table of N_s (Source) via path N_i to N_d (Destination)
Construct energy table of E_n via path N_{Ii} to N_E.
Construct routing table N_s via path N_{Ik} to N_d
Construct energy table of E_n via path E_{ni} and E_{nk} to E_{nd}
}
Step7: Find MAXimum energy of (E_{ni}, E_{nk}) // Find Maximum energy route
Step8: {if (E_{ni} = higher-RSS)
Select route via path E_{nk} to N_d;
else
Select route N_s through path E_{nk} to N_d;
}
Step10: End
}

IV. SIMULATION OVERVIEW AND RESULTS ANALYSIS

(i) Simulation Overview: The simulation is a useful technique since a network's behaviour modelled by calculating the interaction between the different network components (they can be end-host or network entities such as routers, physical links or packets) using mathematical formulas. They can also be modelled by actually or virtually capturing and playing back experimental observations from a real production network. After we get the observation data from simulation experiments, the network's behaviour and protocols can then be observed and analysed in a series of offline test experiments. All kinds of environmental attributes also are modified in a controlled manner to assess how the network can behave under different parameters combinations or different configuration conditions. Another characteristic of network simulation worth noticing is that the simulation program used different applications and services to observe end-to-end or other point-to-point performance in the networks to simulate and get nearly accurate results. We require powerful network simulation tools that predict a network's behaviour without an actual network being present [5]. Since a network simulator imitates a computer network's working, it is a well-suited tool to test all the newly proposed mechanisms to define the various types of devices used in the network. Also, model the network links, the capacity of the links, the traffic load capacity, the type of traffic, each device's behaviour, and various attacks can be simulated to observe the behaviour in an attacker's presence.

(ii) Results Analysis:

Table 6.1 Simulation parameters Use for Simulation

Parameters	**Configuration Value**
Routing Protocol	AODV, Existing, SSRE
Simulation Area	1000m*1000m
Network Type	MANET
Number of Nodes	20,50,80
Physical Medium	Wireless, 802.11 b
Initial Energy (Joule)	100J
Mobility Speed	Random
Mobility Model	Random Waypoint
Simulation Time (Sec)	100Sec
Transmission Range	550m
MAC Layer	802.11p
Antenna Model	Omni Antenna
Traffic Type	CBR, FTP
Propagation radio model	Two ray ground
Transmission Energy	1.5 Joule
Receiving Energy	1 Joule
Ideal Energy	.01 Joule
Sense Power	.175 Joule

(1) PDR Analysis

The Packet Delivery Fraction (PDF) performance metrics represent the percentage of successful data percentage received at the destination.

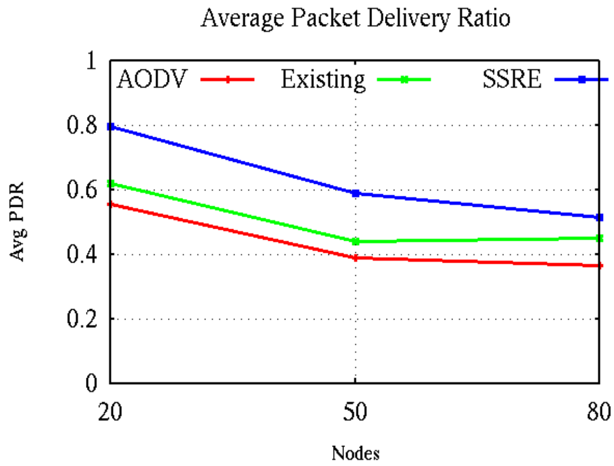

Fig.2. Packet Delivery Ratio Analysis

The number of nodes in MANET is died early due to energy exhaustion. In this graph, the PDR performance of normal energy routing with AODV and proposed Signal Strength & Residual Energy (SSRE) based route selection is evaluated and identified that the PDR of SSRE is more in normal AODV routing, it is low. The PDR performance depends on the ration of input and output. If the data packets are less transmitted as equal to the receiving, it means PDR is good, but large packets transmission data is also received in good quantity. Still, the percentage value is not possible for more than 100%. In the SSRE scheme, packets receiving is more that shows better energy utilisation.

(2) Routing Overhead Analysis

The sender sends the number of routing packets in MANET to establish a connection between the sender and destination. The routing packets in the network also consume energy for sending and receiving. The number of routing packets in normal energy AODV routing is more routing load due to link breakage occurring the condition of retransmission in MANET. The performance of the proposed SSRE routing is much better than normal. In proposed SSRE routing, the routing packets delivery is less due to strong link connectivity. The total routing packets in normal energy routing are more than 7000 packets (maximum), but the quantity is about 6000 packets. The nodes selected for communication are reliable in terms of energy capacity. The possibility of data loss and retransmission is reduced and provides better data delivery in a given simulation time.

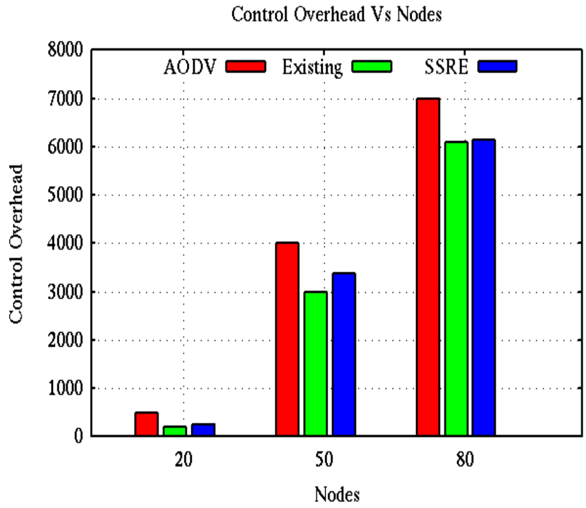

Fig.3 Routing Load Analysis

(3) Average Route Length Analysis

In route performance metrics is defined as the number of packets measured in the network per unit of time—the time in the simulation we consider in seconds. Every communication in MANET is done by limited source energy of mobile nodes. The energy consumption of mobile nodes also reduces the working capability of nodes. The route length in the case of SSRE routing is about two maximum in the 20-node density scenario, and it shows the strong connectivity among the nodes. Compared to SSRE, the performance of normal energy AODV routing is about 1.50, and existing is about 1.7. The throughput performance of the proposed SSRE scheme shows the energy utilisation is more in data packets receiving. It minimises the energy consumption, possibility of retransmission that enhance the network lifetime of the network.

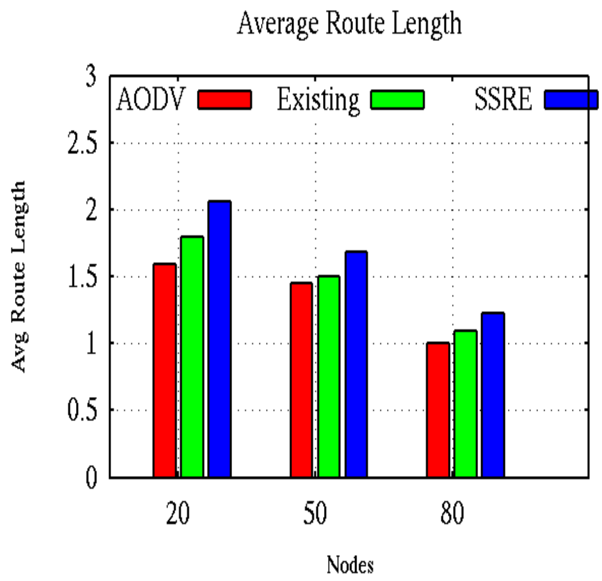

Fig.4. Average Route Length Analysis

(4) Data packets receiving Analysis

The numbers of packets are measured at the receiver end to evaluate through the counting of data received. In this graph, the packets receiving performance is compared with normal energy routing and proposed SSRE energy routing. The performance of the proposed scheme has confirmed the stability and reliability of data receiving. The protocol performance is fully dependent on network conditions like heavy loaded, lightly loaded. The packets receiving proposed SSRE are 7000 packets in 80 node density scenarios, but in normal routing, the performance is about 5500. The difference in performance is more than double.

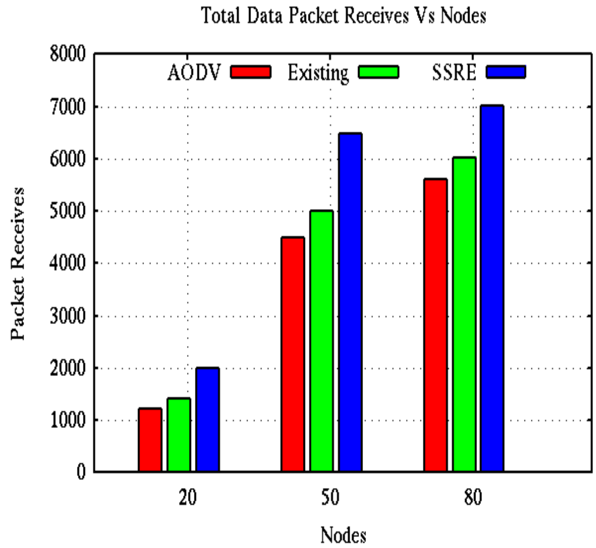

Fig.5. Total Data Packets Receiving Analysis

(5)End to End Delay Analysis

The less delay in the network shows a reliable end to end communication in the network. The transport layer is responsible for maintaining data packets receiving between the sender and the receiver. The proper acknowledged (ACK) concept after receiving data

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ensures proper data delivery. The receiver receives the next data packets transmission based on the ACK of the first one. This graph evaluated the send to end delay analysis of normal AODV energy routing with three node density scenarios. Here the delay in the proposed SSRE is less due to the proper connectivity of nodes. The energy exhaustion has degraded the performance because of a weak link establishment. As usual, the strong link establishment is to improve the possibility of successful data receiving.

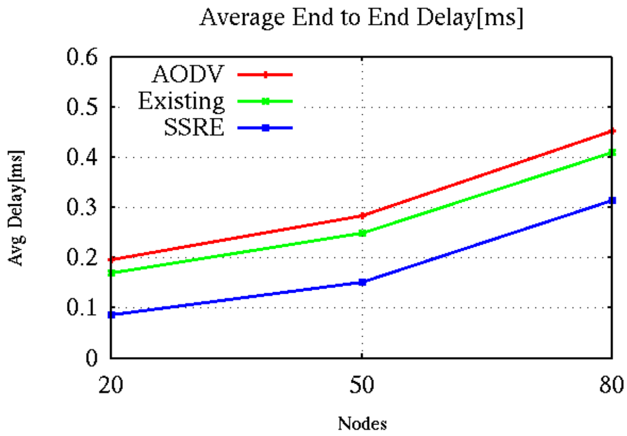

Fig.6. End to End Delay Analysis

(6) Control Packet Bandwidth Utilization

The proper communication represents the packets receiving is proper at the destination with minimum data loss in a dynamic network. The number of connections packets receiving is better due to the strong link establishment between sender and receiver. This graph represents the proper data receiving of the SSRE scheme. Observation of proposed SSRE consumes less bandwidth for control packets, and the rest of the two performances consume lesser bandwidth that is consuming more energy in communication.

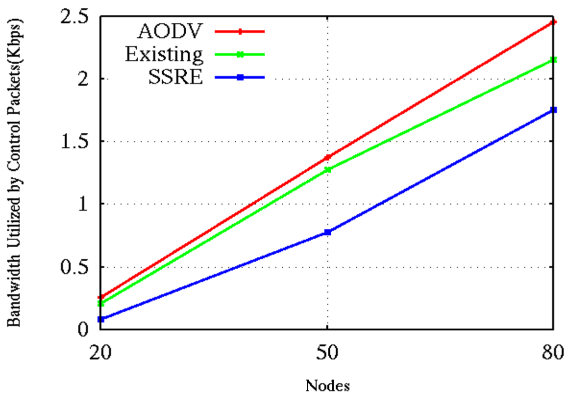

Fig.7 Bandwidth Utilization Analysis

(7) **Route Error Message Analysis**

The network's route error occurs due to link breakage and the next node's unavailability for communication. The energy consumption of mobile nodes also reduces the working capability of nodes. The RERR packets in SSRE routing are about 57% up to the end of simulation time, and 80% observe in normal AODV routing protocol in MANET. The RREQ packets in the case of the existing scheme are about 76%. The less amount if RREQ packets show the better utilisation of the route.

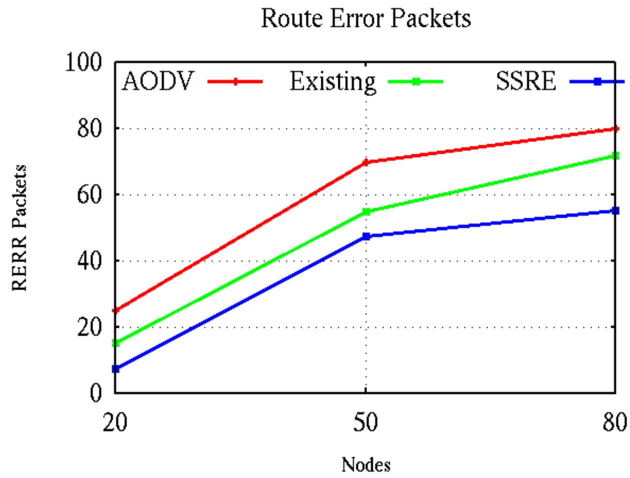

Fig. 8 Route Error Message Analysis

V.CONCLUSION

The Mobile Ad hoc Network (MANET) is a group of mobile nodes that communicate through limited battery power resources. A mobile node may lose connectivity with the rest of the network simply because it has wandered off too far, or its power reserve has dropped, and energy reaches below a critical level. If the link is broken unexpectedly, then the loss of data is again retransmitted through another path. The proposed Signal Strength & Residual Energy (SSRE) based route selection scheme is always select the higher Received Signal Strength (RSS) energy nodes for sending packets. The proposed SSRE considered the remaining battery energy of nodes and was used as a benchmark to study the proposed algorithm's energy efficiency. Extensive simulations showed that SSRE saves more energy than existing energy-efficient routing algorithms and increases the link establishment's reliability between sender and receiver in MANET.

Furthermore, we observed that SSRE finds routes that their energy efficiency and reliability are compared to the route discovery of normal energy-based routing. However, SSRE also extends the network lifetime by directing the traffic to nodes with more battery energy. The proposed algorithm simulation performance is much better, and double packets are sending and receiving in the network. The routing overhead is almost more than half reduces; that is the sigh of better routing in MANET. The proposed scheme utilises the energy consumption of mobile nodes and reduces the possibility of retransmission. The power consumption is not utilised more for route request but data delivery. The larger packets receiving is demonstrated the corroboration of strong link establishment.

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