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Energy-Efficient and Optimized Reverse Path Based Routing Mechanism for MANET

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***Abstract* - In MANETs, there is no central infrastructure to observe or distribute the assets used by the mobile nodes. Most of the on demand routing protocol, including AODV use single route reply along the reverse path. The extended AODV called Reverse Ad Hoc On Demand Vector (R-AODV) protocol uses a reverse route discovery mechanism and performs well when link breakage is frequent, which reduces overhead of routing and obtains better performance than the AODV and other protocols have by sending multiple reverse-RREQ. Energy consumption happens due to multiple Reverse-RREQ. We have modified Reverse AODV by considering the main aspects, e.g. energy consumption and route stability/reliability. Simulation results is been carried out in Network Simulator 2 (NS2). Because of Updation in Reverse-AODV a new route with better life-time is being selected among available routes and which is creating good impact on targeted factors. So in high mobility environment, as compare to AODV and RAODV, the Proposed algorithm shows better results.**

***Keywords* - Mobile Ad-hoc Networks; Ad-hoc On Demand Distance Vector, Reverse Ad-hoc On Demand Distance Vector, Route Request, Route Reply, Reverse Route Request**

I. INTRODUCTION

Wireless networking is an emerging technology that permits users to access information and services, without considering their geographic position. Two way to classify wireless communication between mobile hosts, ones is Infrasturcture Network and another one is Ad-hoc network. According to first approach, use a fixed network infrastructure that has wireless access points. When it comes out of range of one access point, it connects with a new access point within its range and starts communication through it. An example of this type of network is the cellular network infrastructure. The second approach is to build a wireless ad hoc network among users demanding to communicate with each other with no established infrastructure. Devices like laptops and personal digital assistants (PDAs) that communicate directly with each other are examples of nodes in an ad hoc network. [1]

A Mobile Ad Hoc Network (MANET) is a set of mobile nodes that perform basic networking functions like packet forwarding, routing, and service discovery without the need of an established infrastructure. Multiple intermediate hops are generally needed to reach other nodes, due to the limited range of the nodes. Each and every node in an ad hoc network must be keen to forward packets for other nodes. This way, every node performs role of both, a host and a router. The topology of ad hoc networks is dynamic and changes with time as nodes move, join or leave the ad hoc network. This unsteadiness of topology needs a routing protocol to run on each node to create and maintain routes among the nodes[1].

MANET is infrastructure-less network , so It is very popular in application like military battlefield, natural disaster, collobrative work and personal area network. But it comes with some challenges also like limited bandwidth, dynamic topology, routing overhead, packet loss and bettary constrains[2,3].

Energy of each node is also important factor when we are talking about routing. If we lose node just because of it energy, we lose whole route in which transmission of data is happening and it also affect the lifetime of a network. And that bring us to find a new route.

In this paper, we aim to provide a mechanism that is used to increase network lifetime, which leads us to better performance. In Section II, RAODV protocol is discussed. In Section III, focus is on several modification happened in RAODV protocol till date. Section IV presents our proposed scheme in detail. With conclusions in section V follows references at the end.

II. BACKGROUND THEORY

Reverse Ad hoc On-Demand Distance Vector (RAODV) Protocol

In high mobility, pre-decided reverse path can be disconnected and route reply message from destination to source can be missed. So R-AODV protocol discovers routes on-demand using a reverse route discovery procedure. During route discovery procedure source node and destination node plays same role from the point of sending control messages. Thus, after receiving RREQ message, destination node floods reverse route request (R-RREQ), to find source node. When source node receives an R-RREQ message, data packet transmission is started immediately.

1) Route Discovery

Since R-AODV is reactive routing protocol, no permanent routes are stored in nodes. By broadcasting the RREQ is done to initialize route discovery procedure. The RREQ message contains following information

Type	Reserved	Hop Count
Broadcast ID		
Destination IP Address		
Destination Sequence Number		
Source IP Address		
Source Sequence Number		
Request Time		

Table-1: RREQ Message Format (RAODV)

Whenever the source node issues a new RREQ, the broadcast ID is incremented by one. Thus, the source and destination addresses, together with the broadcast ID, uniquely identify this RREQ packet. The RREQ to all neighbouring nodes within its transmission range. These neighboring nodes will do the same, the RREQ to other nodes. As the RREQ is broadcasted in the whole network. When an intermediate node receives a RREQ, the node checks if already received a RREQ with the same broadcast id and source address. The node cashes broadcast id and source address for first time and drops redundant RREQ messages. The procedure is the same with the RREQ of AODV.

As soon as first route request message is received by destination node, reverse route request is being generated and broadcasts it to neighbor nodes within transmission range like the RREQ of source node does. R-RREQ message contains following information: reply source id, reply destination id, reply broadcast id, hop count, destination sequence number, reply time (timestamp).

Type	Reserved	Hop Count
Broadcast ID		
Destination IP Address		
Destination Sequence Number		
Source IP Address		
Reply Time		

Table-2: R-RREQ Message Format (RAODV)

When broadcasted R-RREQ message arrives to intermediate node, it will check for redundancy. If it already received the same message, the message is dropped, otherwise forwards to next nodes.

And whenever the original source node receives first R-RREQ message it starts packet transmission and late arrived R-RREQs are saved for future use. The alternative paths can be used when the primary path fails communications.

III. Related Work

TImportant factor in on-demand routing protocols is Successful delivery of RREP message for ad hoc networks. Large amount of effort is going to waste, if the RREP is lost. In 2006, Chonggun Kim, Elmurod Talipov, and Byoungchul Ahn, at el. [4] Proposed An RAODV routing protocol, with Reverse-RREQ instead of RREP which solves the above problem.

In 2008, Mehdi Zarei, Karim Faez, Javad Moosavi Nya, at el. [5] Proposed a Modified Reverse AODV Routing Algorithm, which select a new route with maximum stability. This algorithm is suitable for high mobility rate environment and shows a good performance when the number of nodes increases.

In 2010, Said Khelifa, Zoulikha Mekkakia Maaza, at el. [6] proposed An energy Reverse AODV, which aims to maximize the lifetime of the network and improve the performance through incorporating the metric "residual energy of nodes" instead of the number of hops in the process route selection.

In 2012, R.Senthil Kumar, P.Kamalakkannan, at el. [7] proposed a Personalized RAODV Algorithm. This approach can reduce the link break using prediction of received signal strength and link expired time to reduce number of packet loss and hence improve QoS in MANET.

In 2013, Tariq A. Alahdal, Saida Mohammad, at el. [8] Compared the performance of AODV, DSR, DSDV, RAODV, AOMDV, and TORA. Comparison is based on two testing network parameters: traffic load and pause time using RWP model mobility. AODV family protocols have better performance than the other protocols. Specifically, they outperform the other protocols in terms of PDR. However, AOMDV is better than RAODV and AODV in terms of delay. Whereas, RAODV and AODV are better than AOMDV in terms of throughput.

IV. PROPOSED WORK

We proposed an approach for extending the network lifetime when using RAODV routing protocol in MANET. We have not made any changes as far as RREQ goes to source node to destination node. Changes have been done in sending R-RREQ destination node to source node. Energy value is new parameter in R-REQ message format energy of each node will be added to this value to find route energy value.

Type	Reserved	Hop Count
Broadcast ID		
Destination IP Address		
Destination Sequence Number		
Source IP Address		
Reply Time		
Energy value		

Table-3: R-RREQ message format (Proposed Method)

Based on that route energy value and hop count, which comes in R-RREQ message format, sill value will be calculated. The Sill value will be compared with the route energy value and from it, better life time routes will be found and selection of route will be done among those routes.

Flowchart of proposed method

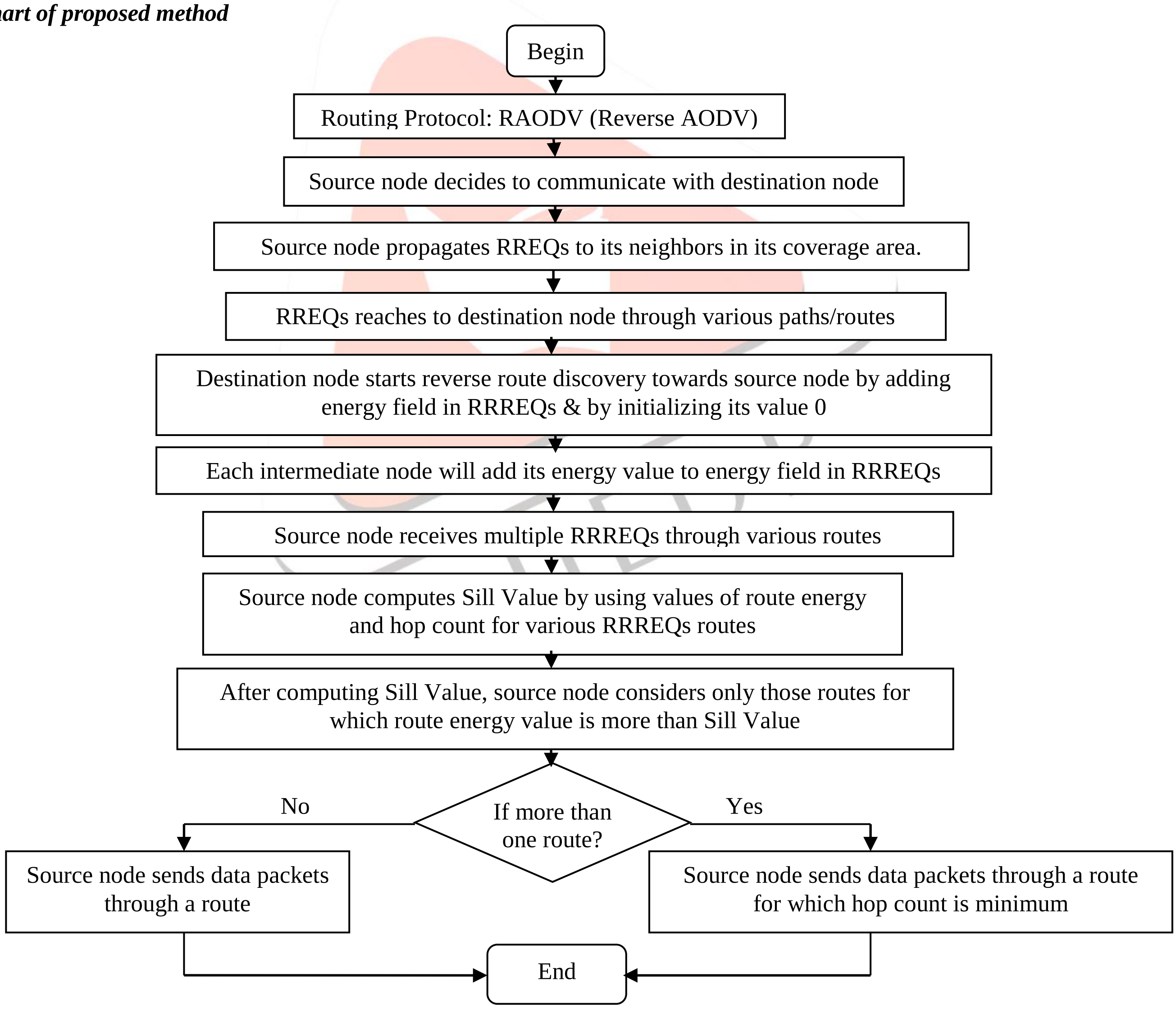

Fig. 1: Flowchart of Proposal Work

B. Implementation steps of proposed method

1. Routing Protocol: RAODV (Reverse AODV)
2. The source node decides to communicate with the destination node

3. The source node propagates RREQs to its neighbors in its coverage area.
4. RREQs reaches to destination node through various paths/routes
5. Destination node starts reverse route discovery towards source node by adding an energy field in RRREQs & by initializing its value 0.
   Let's assume that energy field value as $\mathbf{REV_r = 0}$ for each individual route r.
6. Each intermediate node will add its energy value to energy field in RRREQs.
   $\mathbf{REV_r = REV_r + E_i}$
   Where $\mathbf{E_i}$ is energy of an intermediate node i and $\mathbf{REV_r}$ is total energy of a route r.
7. Source node receives multiple RRREQs through various routes.
8. Source node computes Sill Value (γ) by using values of route energy (REV) and hop count (HC) for various RRREQs routes as per following equation.

$$\gamma = \frac{\sum_{i=1}^{r} REVi * HCi}{\sum_{i=1}^{r} HCi}$$

   Where **REV** is total energy of a route r and **HC** is the total number of hop counts in route r.
9. If (Route Energy Value (REV) > Sill Value (γ)) {
   If (More than one route) {
   Source node sends data packets through a route for which hop count is minimum
   }
   Else {
   The source node sends data packets through a route
   }
   }
   Else {
   Discard a route.}

Consider the image shown below:

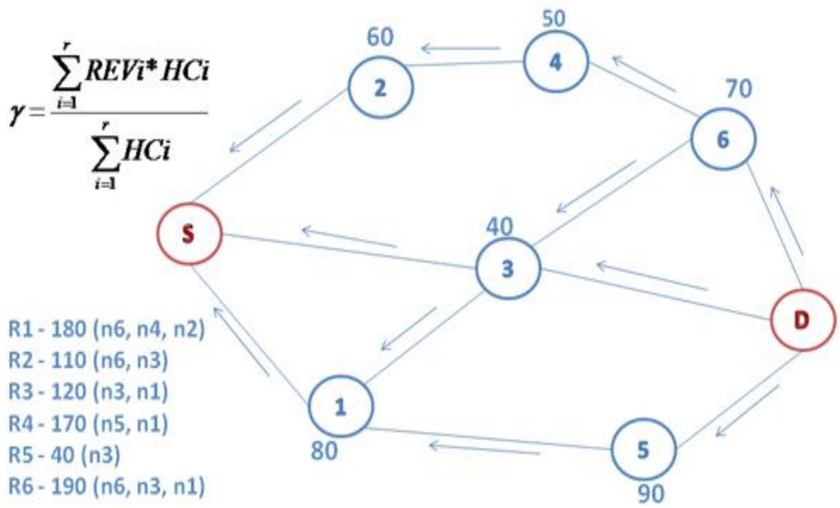

Figure 2: Network with Route Energy

As shown in figure-2 we have some nodes and its energy value based on that we are calculating energy of each route. With the help of that route energy and hop count of the each route will find the Sill Value. Select the route which have more energy value than Sill Value and from that selected route we will choose the route which has less hop count.

V. RESULTS

In this section, firstly we narrate simulation environment used in to get result and then see the results.

Simulation Environment

Parameter	Value

Simulator	NS-2(Version 2.34)
Channel type	Wireless
Radio-propagation model	Propagation /TwoRayGround
Network interface type	Phy/WirelessPhyExt, Phy/WirelessPhyExt
MAC Type	Mac /802.11
Interface queue Type	CMUPriQueue
Link layer type	LL
Antenna model	Antenna/Omni Antenna
X dimension of the topography	1000
Y dimension of the topography	1000
Max packet in ifq	50
Number of mobile nodes	25, 40, 55 Nodes
Traffic Type	UDP, CBR
Routing Protocols	AODV, RAODV, Pro-RAODV

Table-4: Simulation Environment

Results

To analyze the performance of Proposed RAODV with AODV and RAODV protocol, we compared them using four metrics:

- Packet Delivery Ratio - Its a ratio of packet recieved at destination node to the packet sent by the supply node.
- Average End-to-End Delay - Its a duration of time between sending by the source node and receiving by the destination node, which covers queuing time and processing time both.
- Throughout - It is total packets successfully delivered to individual destination over total time divided by total time.
- Average Remaining Energy - Remained energy of each node.
- Routing Overhead - It is defined as the total number of routing packet transmitted per data packet.

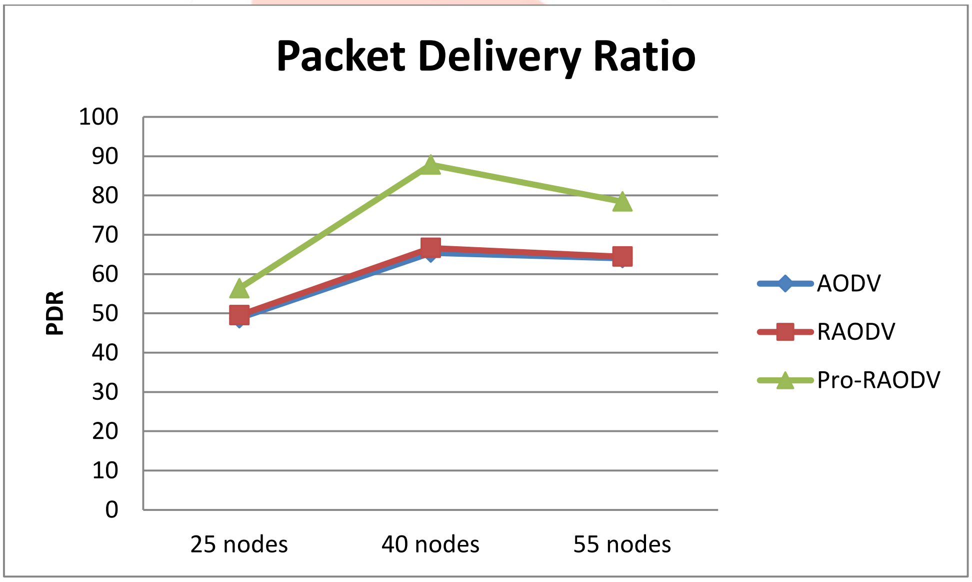

Figure 3 – Packet Delivery Ratio

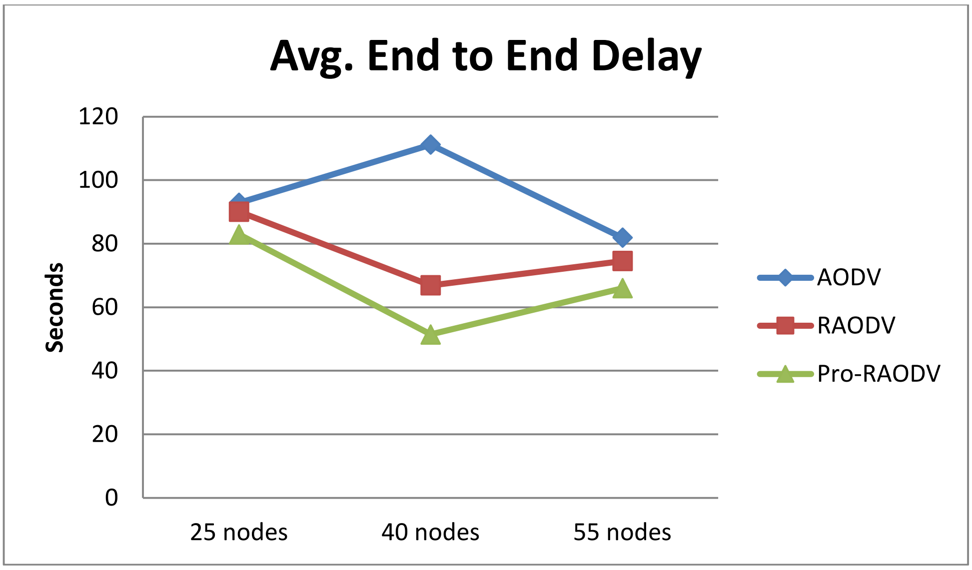

Figure 4 – Average End To End Delay

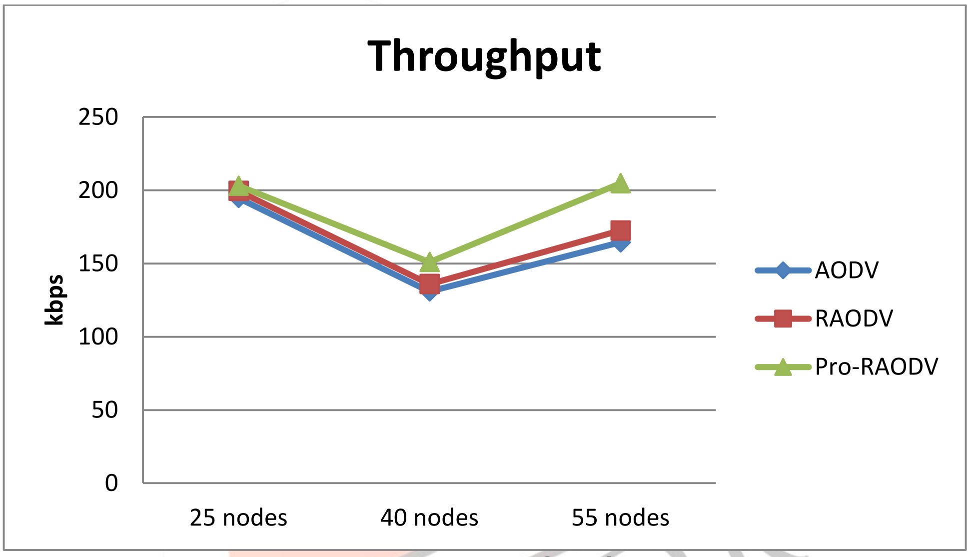

Figure 5 – Throughput

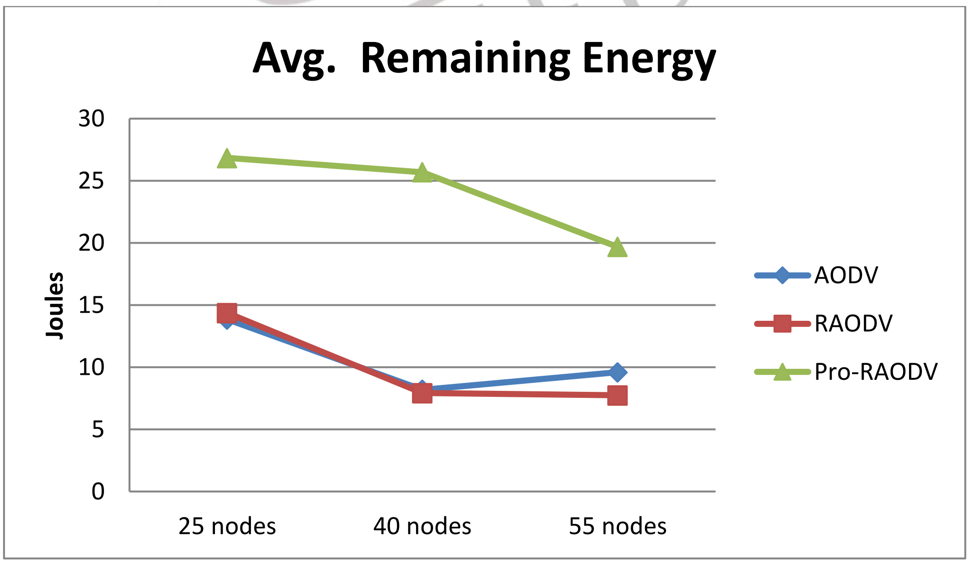

Figure 6 – Average Remaining Energy

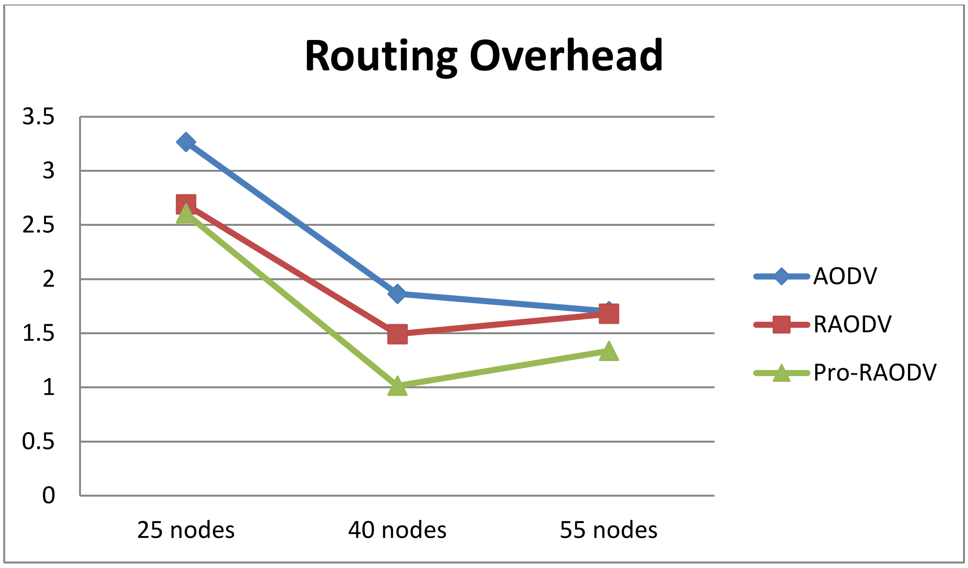

Figure 7 – Routing Overhead

According to our proposed method we are focusing on stability of route and making it energy efficient during route selection process which lead us to achieve good results as compare to AODV and RAODV.

VI. CONCLUSION

MANET consists of wireless nodes which communicate with each other through wireless links without any established infrastructure. Intermediate nodes establishs communication between the two nodes when both are out of transmission range. Frequent change of the network topology, because of the mobile node, is a main challenge for many important topics, such as routing protocol, robustness and performance degradation. RAODV is also improving loopholes of AODV but that also effects some other factor also. So for increasing of protocol performance in terms of energy, we are using the expression through which better route among the available routes is being selected for data transmission. We have presented proposed routing protocol which can be an extension of RAODV. Performance of proposed protocol is being compared with AODV and RAODV routing protocol for 25 nodes, 40 nodes and 55 nodes and from performance point of view, some of the factor like energy, packet delivery fraction, routing overhead, throughtput and end to end delay is showing that the proposed protocol is superior to these protocols.

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