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Review on Energy Efficient Routing Protocol in MANET

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Abstract: Mobile ad hoc networks are infrastructure-fewer networks required for establishing communication between two or more nodes without creating a common access point. There are so many routing protocols introduced in the recent scenario. In the case of On-Demand routing algorithms like AODV and DSR were taken as one of the effective scheme for achieving good Quality of service parameters compared to Table Driven method. Establishing correct and efficient routes is a main design problem in MANETs along with Energy Efficiency. Energy based papers proposed in the recent years consider the on-demand routing of AODV and DSR and some modifications have been done in order to find out a better energy efficient routing algorithm. This paper is a review of new and improved energy based routing methods used in Mobile Ad hoc networks.

Index Terms: MANET; Clustering; Energy consumption; AODV; DSR; Qualty of Service; Routing protocol.

I. INTRODUCTION

An Ad Hoc Network is a multi-hop wireless network that contains self configurable mobile nodes interconnected by denotes of wireless medium without having any fine-tuned infrastructure. Its fast and simple deployment in a situation where it's more difficult to set up any fixed infrastructure network, has demanded the potential used in different fields such as in emergency, disaster relief actions, conferences and etc. A mobile ad hoc network MANET are characterized by the mobile nodes which can move in any direction and are self-configurable, self-maintaining and self-organizing themselves within the network by the means of radio links and without any fixed infrastructure like base station, routers, fixed link, and centralized servers. So, the overall functionality along with the routing mechanisms is incorporated in every node which indeed consumes a good amount of battery power. Other process like topological updating when a node moves out of the network, the sending and receiving of packets, processing of packets and then routing the packet through its neighboring node also consumes heavy power [1, 2]. So we can assume that in MANETs, the power gets consumed mainly in two ways. Firstly, by transmission of data to a destination and secondly, the mobile node may offer itself as an intermediate packet forwarding node in the network. The energy level of the nodes are also getting affected of the ease with which route can be established between two end points. Mobile ad-hoc networks have turned the vision of establishing connections at any time anywhere. Recent progress such as Bluetooth introduced a new type of wireless systems known as mobile ad-hoc network. Mobile ad-hoc networks operate in the absence of fixed infrastructure. Nodes in mobile ad hoc networks have a restriction of limited battery power for their operation. Hence, the energy efficiency is an important issue in mobile ad hoc networks. Some of the characteristics of mobile networks are summarized as follows:

- Communication through wireless means.
- Nodes can act as both hosts and routers.
- No centralized controller and infrastructure.
- Dynamic network topology, continuous routing updates.
- Self operating, no infrastructure needed.
- Can be established anywhere.
- Energy limitations
- Limited security

Key challenges in Mobile Ad hoc networks are as follows:

- Limiting power supply
- Dynamically altering Topology
- Bandwidth constrained
- Security
- Mobility-aware route change
- Battery constraints

II. ENERGY CONSUMPTION IN MANET

The routing protocols play a consequent role in mobile ad hoc networks as the nodes are of dynamic nature and each node can perform in routing the data packets. In such scenario, energy efficient routing protocols are required for Ad Hoc networks, when there are no routers, without any base station and fixed infrastructure [3, 4]. So in order to establish the right and efficient routes from a source to destination is not the ultimate goal of any routing protocol, rather keeping the networks functioning as long as possible without any interruption and with low power consumption at each node level, should also be the main objective for these routing protocols. These goals can be

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achieved by reducing the mobile node's energy during both the active as well as inactive communications. Active communication is when all the nodes of the route are involved in receiving and forwarding of data. Minimizing the energy during active communication is possible via two different approaches.

- Transmission power Control
- Load distribution

In dormant communication the nodes are in sleep mode. I.e. neither transmitting any data packets nor receiving any data packets. In such situation, to minimize the energy consumption Slumber/Power down approach is utilized.

III. ROUTING IN MANET

Routing is the process of culling paths in a network along which to send network traffic. A routing protocol is a protocol that designates how routers interconnect with each other, distributes information that enables them to cull routes between any two nodes on a computer network, the selection of the route being done by routing algorithms. A routing protocol distributes this information firstly among immediate neighbors, and then throughout the network [3]. This way, routers assimilate erudition of the topology of the network.

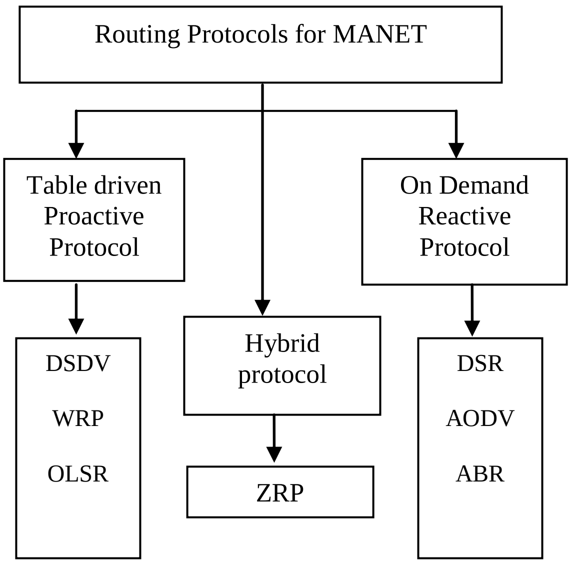

Figure1. Different types of routing protocols in MANETs

These algorithms are based on the some of the following areas:

- Keeping track of the residual battery power.
- Keep record of the previously used paths.
- Keeping back-up paths.
- Keeping track of the message overhead.
- On-demand calculation/updation of routing tables.
- Transmitting data packets at a lower energy compared with the RREP/RREQ.
- Moving the nodes inactive state when they are not required.
- Using an ordered routing scheme.
- Using directional beam antennas.
- Requiring a node to transmit the data packets with energy proportional to the distance rather than with fixed energy.
- Transmitting the data packets by considering the actual amount of energy required to forward data.

IV. LITERATURE REVIEW

A. Energy Saving and Survival Routing Protocol for Mobile Ad Hoc Network.

Baisakh and Nileshkumar R.Patel introduced a Scheme to enhance the life time as well as ameliorate the performance of the mobile ad hoc networks (MANET). They have treated DSR routing protocol as our base protocol and we endeavor to make some alteration on it which operates into an efficient energy preserving and survival DSR (ESSDSR). They have selected DSR because it is one of the important protocol which does not take energy into consideration and once the dedicated path is build between source to destination then it will keep transmitting through that path until the link is broken due to mobility of the node away from its neighbor nodes or any of the intermediate node exhaust out from its energy and so it is considered as one of the unusual routing protocol. Whereas ESSDSR perform not only like an energy efficient routing protocol but also pretend an energy survival instinct. It builds a route from source to destination where packet transmission can be done for a long period of time through the nodes having high caliber of residual battery potency. It withal apprises the source node if any node has low battery energy, so that an incipient path can be discovered for the same destination prior the path get beaked and data transmission get damaged. And so the number of packet drops and retransmission can be reduced.

ESSDSR ALGORITHM

Step-1 At the commencement of the communication from source to destination, the route revelation will be done as per the traditional DSR routing protocol where the dedicated path will be culled on the substructure of the minimum hop count as all the nodes are having same initial energy, surmises to be 100% of battery power.

Step-2 Whenever an energy level less than or identically tantamount to the certain threshold then low energy field in the DSR header packet will be forward to its neighbor nodes by setting up 1.

Step-3 When the neighbor node of the affected node receives The forwarded packet sent by the affected node, then they will abstract the path to that node from its route cache and send an error (Route Error) to the source.

Step-4 the moment source will get the error message it will commence route revelation process ascertaining the path from source to destination without involving the affected node.

Step-5 Now the delay will be introduced to RREQ packet according to the rest of the energy power of the battery. So The node with higher energy will have lesser delay and reaches out early to the destination.

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In two cases our method has shown better results than the DSR: one in increasing the time period of the individual node and the total network life time. At the terminus of the simulation, the rest of the energy of the individual node is shown in the figure-1. The node 1, 3, 5, and 7 are thoroughly used and their energy level became zero. The rest of the nodes which were moderately used are having higher energy level than that of pristine DSR. The life time of these nodes are drastically ameliorated and as their remaining energy is more in ESSDSR as compare to DSR, they can be used further for the data communication.

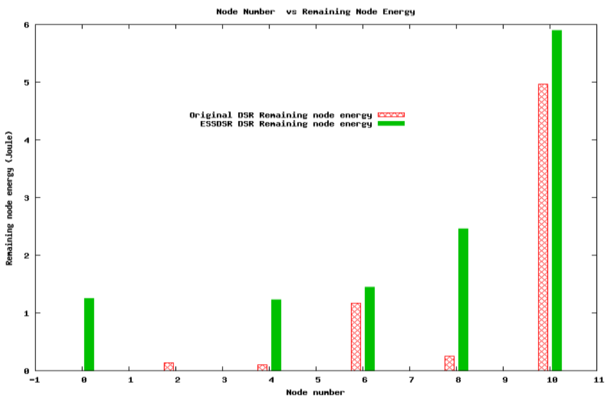

Figure.1. Energy Consumption of Nodes

From the figure-2, it is shown that the network life time has been more doubled. From the experiment, we calculate the network life time of the network by ESSDSR is increased up to 49.831 second while the network life time by DSR is 31. 016 sec. So there is improvement in total life span of the network is of 61.71 percentage.

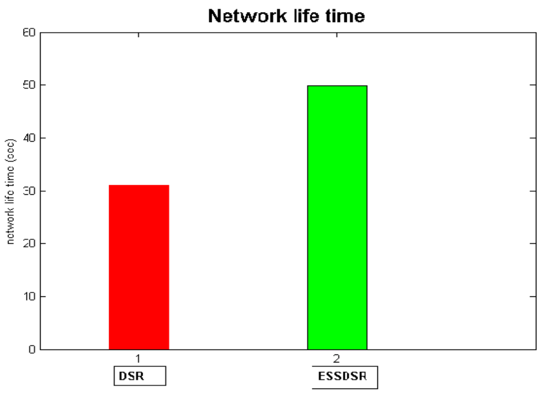

Figure.2. Network Lifetime

B. ENHANCED CLUSTURE BASED ROUTING PROTOCOL FOR MANET.

Kartheek Srugaram and Dr. MH Krishna Prasad Introduced a algo Enhanced CBRP, a schema to amend the cluster stability and in-turn amends the performance of traditional cluster predicted routing protocol (CBRP), by electing better cluster head utilizing weighted clustering algorithm and considering some crucial routing challenges. Moreover, proposed protocol advice a secondary cluster head for each cluster, to increase the stability of the cluster and implicitly the network infrastructure in case of unexpected failure of cluster head. ECBRP makes utilization of Weighted Clustering algorithm (WCA) for electing cluster heads [8] adopts a amalgamated weight metric that takes some parameters like ideal node degree, transmission puissance, mobility and the battery power of the nodes to elect cluster heads. Each node calculates its weight as follows:

$$WV = w1\Delta v + w2Dv + w3Mv + w4Pv.$$

Parameter Δv represents degree-difference for every node v. Degree of the node is nothing but in briefly it is number of neighbors of that node (i.e., nodes within its transmission range), Dv is defined by sum of the distances with all its neighbors. The running average of the speed for every node till current time T gives a quantification of mobility and is denoted by Mv. Pv implicatively insinuates how much battery power has been consumed. While coming to route discovery and transmission of data, the process is same as CBRP. ECBRP differs with CBRP when a routing damaged because of cluster head failure. In CBRP, while transmitting data from source to destination, if route error appear because of some reason (i.e., the next node in the path may died or moved away from the transmission range of the node which is currently transmitting the packets), the node which found route error will endeavor to salvage the route. Otherwise, it engenders route error packet and tells to source. But in ECBR, if route error occurred, the current node first detects whether the next node is cluster head or not. If it is a cluster head, then in the path the cluster head will be superseded by the secondary cluster head of that cluster. As the performance of network is tightly bound with the frequency of cluster reorganization, the proposed algorithm avails to reduce the frequency of cluster reorganization and increases the network performance.

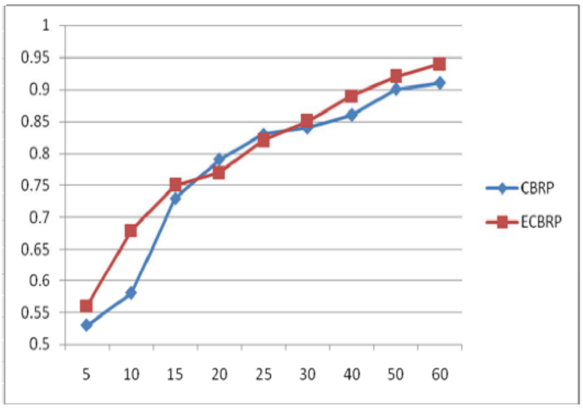

Figure.3. Changing no. of nodes to Packet delivery ratio

In Figure 3 from the experiment it is clear that the Enhanced CBRP performs well, when compared with traditional CBRP.

C. Energy Efficient Real Time Multicast Routing in Adhoc Networks.

Bulent Tavli presents multicasting through Time reservation utilizing adaptive control for energy efficient (MAC-TRACE) an energy efficient authentic time data

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multicasting architecture for mobile adhoc networks, MC-TRACE is a cross layer structure where the network layer functionality and the medium access control functionality are performed by a single integrated layer. The rudimental concept of multicast routing part of the architecture is to establish and maintain an active multicast tree circumvented by a passive mesh within a mobile Adhoc network. Thus the MC-TRACE multicast backbone is a condensed passive mesh interlaced around a highly pruned tree. Albeit tree-and mesh-based multicasting techniques have been used discretely in exiting multicast architecture, this method integrates and reengineers of the tree and mesh structures to make them highly energy adequate and strong for authentic - time data multicasting in mobile ad hoc networks. Energy efficiency is extracted by allowing the nodes to switch to slumber mode frequently and by eliminating most of the redundant data receptons.MC-TRACE gives superior energy efficiency while engendering competitive QoS performance and bandwidth efficiency.

D. Improving Performance of Clustered Based Routing Protocol using Cross-Layer Design.

Seyed Kazem JahanBakhsh & Marzieh Hajhosseini Incipient a new approach to cross-layer design of CBRP to enhance its efficiency with reverence to the esse of mobility in Ad hoc networks. Cross-CBRP, by considering multiple layers such as physical, MAC and network layer endeavors to provide an adaptive clustering algorithm. They precisely compared performance parameters of our proposed approach with the pristine CBRP such as rate of cluster head changes, throughput, packet delivery ratio, delay and over head.

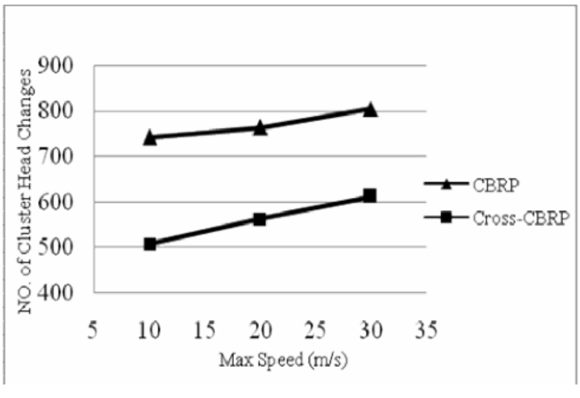

Figure.4.Number of cluster head changes vs. speed.

Fig.4 shows that Cross-CBRP outperforms CBRP by averagely 37% improvement for cluster head changes. It is very clear that Cross-CBRP yields a remarkable gain over CBRP because of its capability of adapting itself to the mobility of nodes. From cluster head changes vs. mobility curve, we can conclude that Cross-CBRP is suitable for stable cluster formation in situations involving mobility.

Throughput is defined as the average number of data packets received at destinations during simulation time and packet delivery ratio is defined as the total number of data packets sent by traffic sources to the total number of data packets received at destinations, overhead is defined as the total number of control packets including hello packets and finally end-to-end delay is defined as the average time elapsed that a packet originated at the source node, receives at the destination node. Fig.5 demonstrates the packet delivery ratio differences of two algorithms in the existence of mobility. In average the Cross-CBRP performs about 9% better than CBRP because of the cross-layer adaptation technique that has been used in its design. The throughput plays an important role in comparing different network protocols from QoS perspective.

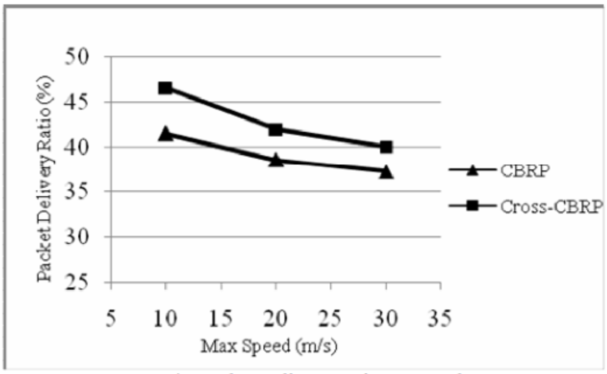

Figure.5. Packet Delivery Ratio vs. Speed

Fig.6 demonstrates the results of measured throughput. The performance results show more efficient behavior of Cross-CBRP in comparison with CBRP with respect to mobility. As it is apparent, the Cross-CBRP outperforms CBRP about 8.5% which again supports this claim that increasing cluster stability we will give us better network performance.

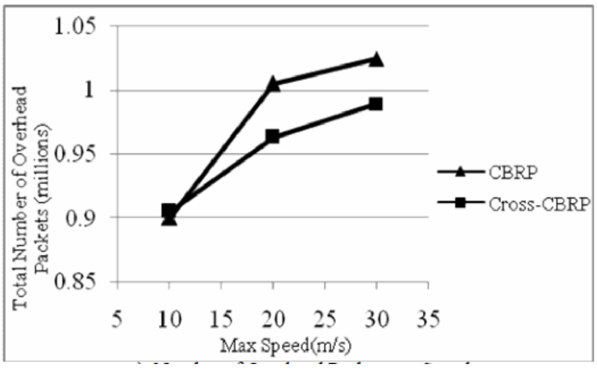

Figure.6. Throughput vs. Speeed

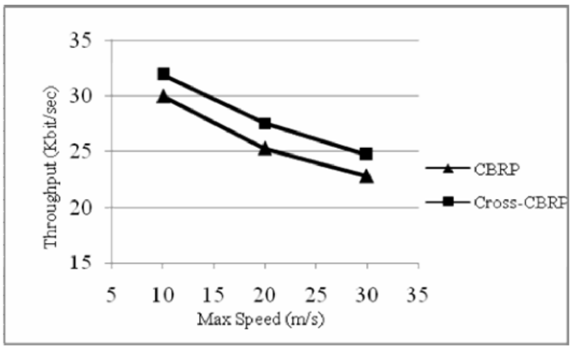

Figure.7. Number of Overhead Packet vs. Speed

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The total number of control packets as the protocol overhead of these two protocols is compared with each other .As depicted from figure.7 it can be seen that Cross-CBRP performs better than CBRP according to this fact that it decreases the cluster reformations.

Fig.8 the end-to-end delay of two protocols analyzed which demonstrates an ignorable difference between them.

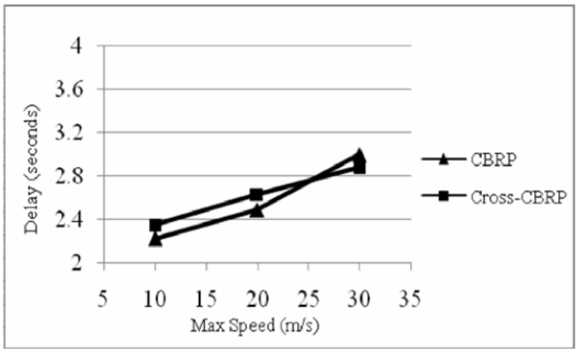

Figure.8. Average End- to- end Delay vs. Speed.

E. Energy Efficient Multpath Routing For Mobile Ad Hoc Network.

May Cho Aye and Aye Moe Aung introduced an Energy efficient multipath routing protocol for choosing energy efficient path. This system also concedes transmission power of nodes and residual energy as energy metrics in order to increase the network lifetime and to diminish energy consumption of mobile nodes. The objective of our proposed system is to establish an optimal route based on two energy metrics concept while choosing a route to transfer data packets. In the traditional AOMDV, it forms multiple paths using RREQs. It does not take into account the energy for choosing the paths. Here the proposed protocol not only takes residual energy but also transmission power of nodes in paths selection to maximize the lifetime of networks.

Transmission Power Control

When a node collects a packet from a neighbor, the channel attenuation is computed as the difference of the transmitted power $Power_{txmax}$ and the received power $Power_{rx}$. The ideal Transmission power can be calculated as follows:

$$Power_{tx} = Power_{txmx} - Power_{rx} + S_r + Sec_{th}$$

Where Sr is the minimal power level required for correct packet reception and Secth is the power included to overwhelm the problem of unstable links due to channel fluctuations. In order to find the best path, the value P can be described as follows:

$$P = maxj\ mini\ (RE/Powertx)$$

Here Powertx is the transmission power and RE is the residual energy of the route.

Residual Energy Calculation

The residual energy is the rest of the energy at every node which is the energy remaining after the packet transmission. The residual energy RE can be calculated by using the following formula

$$RE = EI – EC (t)$$

Where EI is the initial energy of a node and EC (t) is energy consumed by a node after time t. The total energy consumption of all nodes is defined as the following equation

$$TEC = N * Initial\ Energy – RE$$

Here N is denoted as the number of nodes used in the network.

Proposed AOMDV

The performance of the proposed AOMDV protocol is distinguished with that of traditional AOMDV protocol according to the following metrics.

- Average Energy Consumption

It is the average energy used by all nodes in the network. Fig. 9 shows that the proposed AOMDV decreases the total energy consumption than conventional AOMDV even the number of nodes are varied.

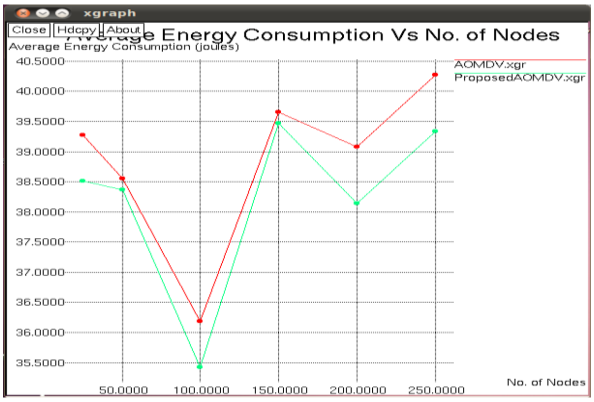

Figure.9.Average Energy Consumption

- End To End Delay

The End to end delay is defined as the average time interval between the transmition of a packet at a source node and the after receiving of the packet at the destination node.

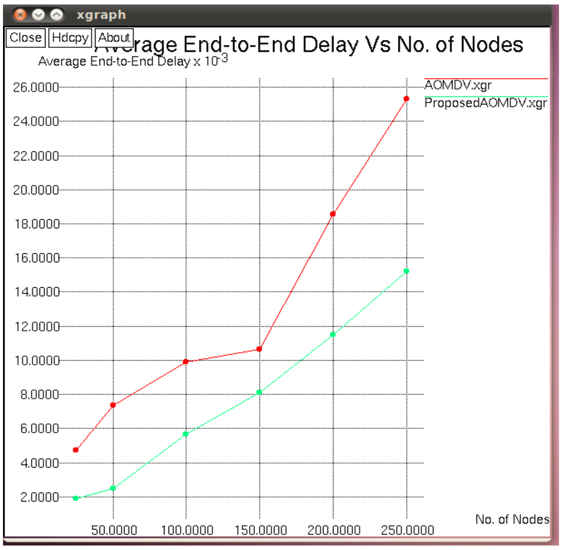

Figure.10.Averge End to end Delay

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In Fig.10, the introduced AOMDV has the lower average end-to-end delay in comparison to AOMDV with different number of nodes. It outperforms energy efficient communication.

• Throughput
The throughput is defined as the ratio of the data packets received at the destination to the data packets transmitted from the sources. Fig.11 shows that the introduced AOMDV is much better than original AOMDV based on throughput.

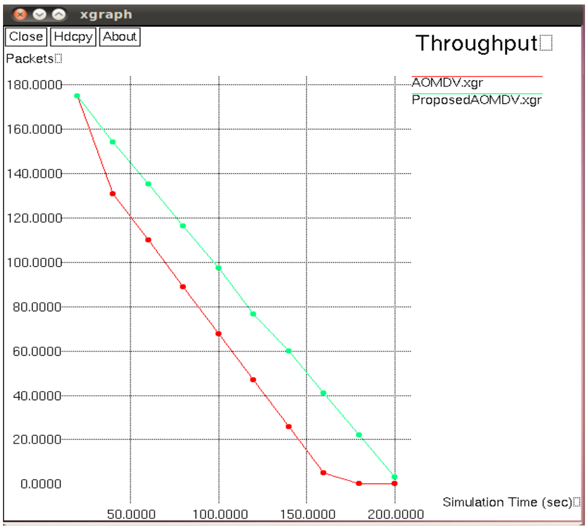

Figure.11 Throughput Comparison.

F. A Clusture Based Trust- Aware Routing Protocol for Mobile Ad-Hoc Network.
Haidar Safa, Hassan Artail and Diana Tabet proposed their A novel cluster based trust-aware routing protocol (CBTRP) for MANETs to save forwarded packets from intermediary malicious nodes. The introduced protocol arranges the network into one-hop disjoint clusters then elects the most qualified and reliable nodes to perform the role of cluster-heads that are accountable for handling all the routing activities. The proposed CBTRP perpetually ascertains the trustworthiness of cluster-heads by superseding them as soon as they become malevolent and can dynamically update the packet path to eschew malevolent routes. They present our cluster-predicted trust active routing protocol (CBTRP) which is a responsive on-demand source routing protocol. To ascertain safe routing path, the proposed CBTRP establishes first the substratum for a trusted environment by providing a mechanism to distinguish trusted nodes from malevolent ones. Cluster members in CBTRP forward packets only through the trusted cluster heads. However, packets from malevolent nodes are not participating and no packet will be forwarded to them. The proposed protocol ascertains the passage of packets via trusted path only by making nodes monitor the demeanor of each other and update their trust tables accordingly. Once a malevolent node is discovered, it is isolated from the network such that no packet is forwarded through or from it. Its performance was evaluated through intensive simulations which fixated on quantifying the impact of scalability and mobility in the presence of maleficent nodes on the packet distribution ratio and the acquired overhead. CPTRP results were compared with those obtained from the 2ACK scheme [12] and the CBRP protocol [9]. Comparison represented that CBTRP protocol gives better performance both the 2ACK and the CBRP schemes in most of the simulation scenarios.

G. Analyzing Video Streaming Quality Over Different Routing Protocols on Mobile Ad Hoc Network.
Jaswant Kumar Joshi, Devendra Singh Bais and Amar Nath Upadhyay examine the performance of four different routing protocols namely ZRP, AODV, AOMDV, and DDIFF to ameliorate the quality of streamed video in Mobile Ad-hoc Network .We use an average throughput, average End-to-end delay and packet delivery fraction (PDF) with respect to varying pause time to examine a video streaming quality over used routing protocols on MANET. They analyzed the performance through simulation by using following performance matrices namely Average throughput, Average end-to-end delay, and Packet delivery fraction. [16]

• Average Throughput Graph
The values of all three used performance metrics are plotted separately for 25 and 75 nodes with different-different pause time, firstly, we consider about the average throughput of 25 nodes which is shown in figure 12.It can be seen from the figure that for 25 node the average throughput of DDIFF is much better for all pause time whereas other use protocols.

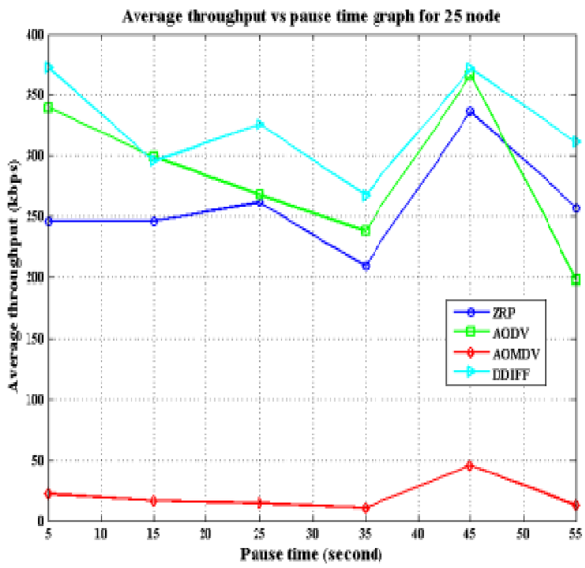

Figure.12.Average throughput for 25 nodes

In case of 75 nodes, the AODV shows different average throughput from the 25 nodes. From figure 13, it can be seen that the AODV shows very high performance whereas for 25 nodes it is moderate. The DDIFF and AODV throughput is high but it is very low for AOMDV and ZRP, so in the case of 75 nodes the AODV performance is better and it increases for high pause time.

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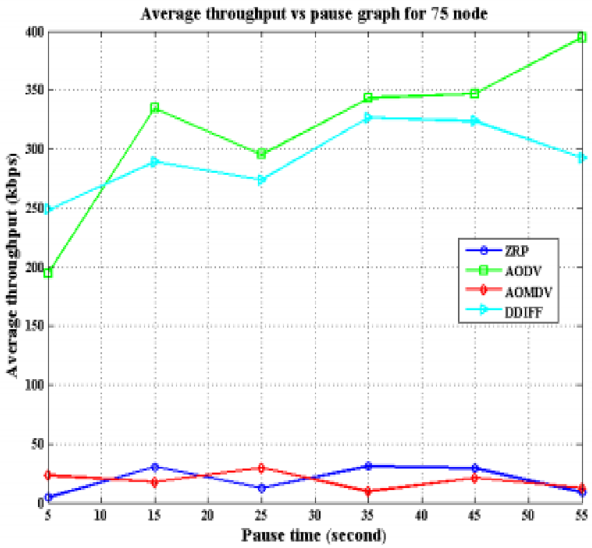

Figure 13.Average throughput for 75 nodes.

• Average End to end Delay

During the 5 seconds of pause time, the AODV Protocol is good but as the waiting time increases the performance of ZRP is good with minimum delay for 15 second to 45 second of time. The AOMDV protocol shows the worst performance for 25 nodes and the delay is much greater as compare to other used protocols. The DDIFF Demonstrate moderate delay and dynamic performance at different pause times shown in figure 14.

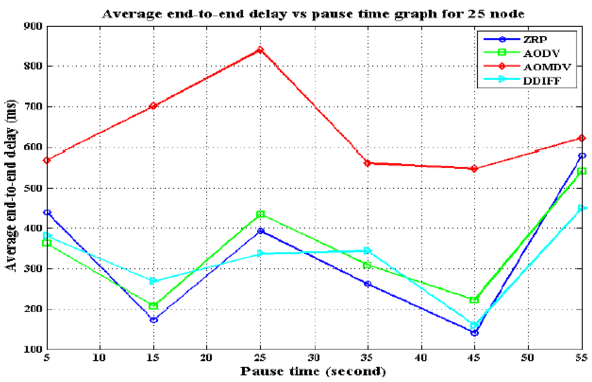

Figure.14. Average End to end Delay for 25 nodes.

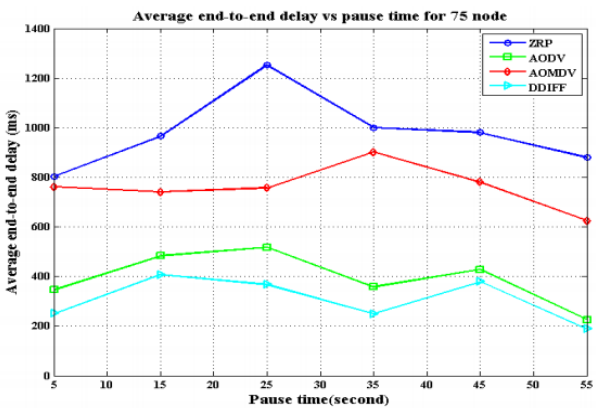

Figure.15.average End to end delay for 75 nodes.

In the case of 75 nodes, as shown in figure 4, the better performance is shown by DDIFF from the average end-to-end delay of 25 nodes. The DDIFF performance for 75 nodes is good with minimum delay. The ZRP protocol shows the highest delay while average end-to-end delay of AOMDV is high but AODV protocol shows moderate performance; hence in case of 75 nodes, the total performance of DDIFF is very good with minimum delay.

• Packet Delivery function

The packet delivery fraction graph for 25 nodes is Shown in figure16. It is clear from the graph that PDF of AODV is highest when the pause time is 5 second whereas at the end when pause time is 55 second it is moderate. From the observation we can say that the performance of ZRP and DDIFF protocol for 25 nodes is quite similar and AODV shows the moderate performance. The AOMDV protocol shows different performance at different pause time. The overall PDF of ZRP protocol is good for 25 nodes.

The PDF graph for 75 nodes is shown in figure17. ZRP performance is opposite for 75 nodes as compare to the 25 nodes performance here at the starting of simulation it is approximately equal to the zero but it increases after 15 second of pause time. Similarly, AOMDV protocol shows High variations in performance with different pause time. The PDF of DDIFF and AODV are closer to each other for 15 second, 25 second and 55 second of pause times. The DDIFF is showing highest PDF for 75 nodes scenario

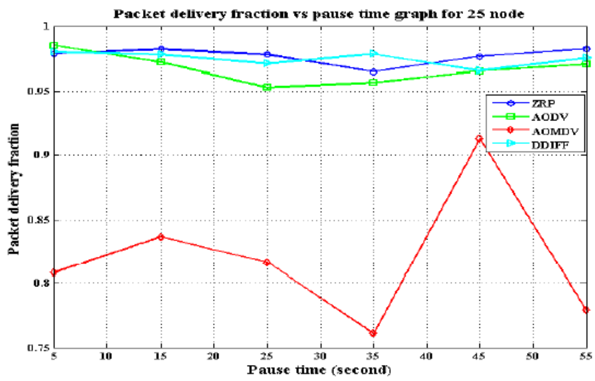

Figure.16. PDF for 25 nodes.

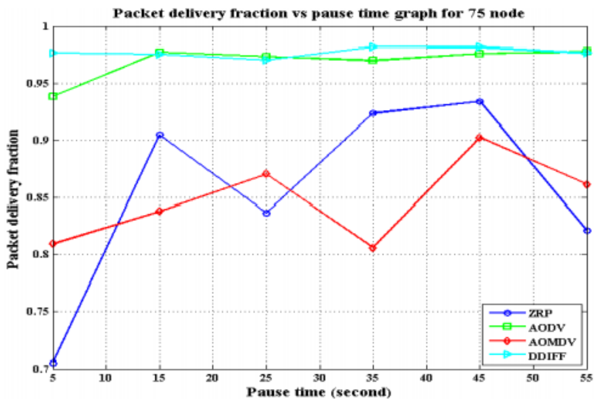

Figure.17.PDF for 75 nodes

The overall performance of DDIFF and ZRP is better in term of packet delivery fraction as well as average end-to-end delay among other used protocols. While, in term of average throughput AODV and DDIFF has produced better results with compare to others. Finally, DDIFF is comparatively better to providing quality in video streaming over different used routing protocols on Mobile Ad-hoc Network.

V. CONCLUSION

In this paper the characteristics of Mobile Ad hoc Networks, their application areas and also the routing in Mobile Ad hoc networks are discussed. The classification of routing protocols, the different types of routing protocols used in Mobile Ad hoc Networks, their advantages & disadvantages are also seen. Energy based routing protocols proposed by various authors are discussed in this paper with regard to Power aware routing, Cluster based routing, Location aided conditions and Progressive Routing in both static and mobility conditions. In contrast to conventional power aware algorithms, EPAR identifies the capacity of a node not just by its residual battery power, but also by the expected energy spent in reliably forwarding data packets over a specific link. Using a mini-max formulation, EPAR selects the path that has the largest packet capacity at the smallest residual packet transmission capacity. This protocol must be able to handle high mobility of the nodes which often cause changes in the network topology.

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