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Comparative Study of the performance of existing protocols of MANET with simulation and justification of an improved Routing Protocol

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***Abstract*— In Mobile Ad-Hoc Networks (MANET), a group of wireless mobile nodes, dynamically constructed without the use of any existing network infrastructure. In such a network, it is quite a challenging task to route a packet efficiently from a source to destination and so various routing protocols have been developed, viz., Ad-Hoc on Demand Distance Vector Routing (AODV), Dynamic Source Routing (DSR), and Destination Sequenced Distance-Vector Routing (DSDV). In this paper, these popular protocols have first been simulated in NS2 Simulator and the results are compared on the basis of some performance metrics such as End to End Delay, Throughput and Packet loss so as to suggest the best routing protocol could establish an best suited effective path from source to the destination. To improve the path establishment in a protocol, a hybrid technique has also been proposed.**

Index Terms*— Mobile Ad-Hoc Network; Routing; Ad-Hoc on Demand Distance Vector Routing (AODV); Dynamic Source Routing (DSR); Destination-Sequenced Distance-Vector Routing (DSDV); NS2*

I. INTRODUCTION

Mobile Ad-Hoc network (MANETs) allows communication between the wireless nodes to form a temporary network without having any centralized administration, thereby, making it a self-organizing and adaptive network. From recent years Manet is assumed to be the noval emerging technology in wireless networks, to facilitate such a communication that there is a sharing of data as well as services between various mobile nodes using routing protocols. In addition, it allows an easy alteration (addition/removal) of nodes to/from the network while still maintaining the connectivity. Although on account of nodal mobility, the network topology may change promptly and uncertainly with time, routing becomes a key challenge in Ad-hoc Networks.

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To address the routing challenge, various routing protocols on the basis of "routing strategy" have been suggested by the researchers. Some of the prime areas of applications of Manet are in Military Battle Field, Rescue Operations, Free Internet Connection Sharing, Device Networks, Sensor Networks, Bluetooth, etc.

The aim of this piece of research work is to adjudge the best effective path in sharing the data and services from source to destination. In this paper, firstly some of the popular routing protocols (DSDV, DSR and AODV) have been reviewed and then on the basis of their individual performance metrics, i.e., End-to-End Delay, Throughput, Packet loss; the results have been compared. After comparison, the best protocol has been suggested alongwith suggesting a further scope of improvement in the existing protocol(s) [1-3].

II. ROUTING PROTOCOLS

Since Ad-hoc Networks have a dynamic topology of interconnections between nodes and such nodes are not required to perform any administrative action, routing protocols helps in selecting the best path for transmission of data packets from source to destination. For path determination, these protocols maintain routing tables which contain route information. To collect the exact route information, various routing protocols have usually been classified into broadly three types, i.e., Reactive type, Proactive type and Hybrid type protocols that has also been depicted in Fig.1.

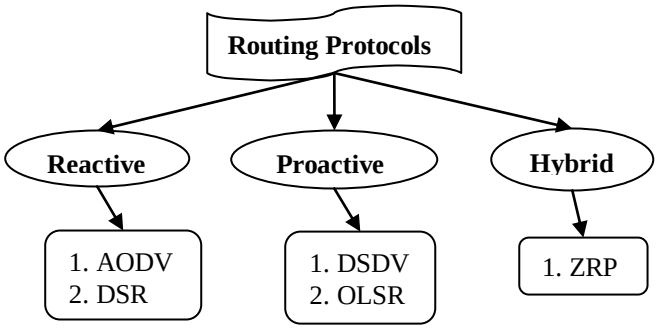

Fig.1. Classification of Routing Protocols

A. Destination-Sequenced Distance Vector Routing (DSDV)

DSDV is a Proactive routing strategy for ad-hoc mobile network. To calculate paths in this routing protocol, the Bellman-Ford algorithm has been adopted. For route selection, it utilizes the hop count as metric means the total number of hops it takes for a packet to reach its destination. This algorithm can solve count even upto infinity or the loop formation problem present in mobile network of routers [2].

Each node in the network in DSDV protocol maintains a routing table in which all the information related to route is stored. Whenever source node wants to send data to destination, the route to the destination is available using that routing table. Routing table updates are sending periodically throughout the network to maintain table uniformity. To resolve the problem of count to infinity or loops, a sequence number is added to the updates. New route broadcasts consists of destination node address, hop count, sequence number of the information received regarding the destination as well as the new sequence number unique to the broadcast. Here the route having the higher sequence number is preferred. In case two updates have the same sequence number, the route with the smaller hop count is used. Full dump and incremental packets are two types of route updates used by DSDV in adjudging the routing efficiently.

B. Dynamic source routing(DSR)

In DSR route is established whenever there is data to send to the destination node so it is termed as reactive routing algorithm which maintains the route throughout. Since in proactive routing protocols, the periodic updates messages are required to maintain route, Johnson D.B., et. al. proposed DSR protocol to restrict the bandwidth occupied by the packets in wireless ad-hoc networks of mobile nodes.
The prime feature that makes Dynamic Source Routing (DSR) different is the use of source routing, this algorithm consists of two major procedures: Route Discovery and Route Maintenance.

Route Discovery: In DSR route discovery process is on- demand. Unlike other protocols DSR requires no periodic updates at any layer within the network and so this led to the reduction in the number of packet updates. When source node S have data to send, first it checks the route cache to determine whether it has route to the destination or not, if available, it will use that route to send the packets else it will initiate the route discovery process. Source node will forward the route request packet (RREQ) to its neighbors; the RREQ contains destination address, source node address and unique identification number. When the RREQ packet is received by the intermediate node, it will check its own route cache first, then if it has route available for destination, then it will send route reply packet (RREP) to the source, else forwards the packet to its neighbors by adding its own address to the route request packet. A route reply is generated when either the route request reaches the destination itself or it reaches the intermediate node that has unexpired route to the destination in its route cache [3]. By using cache routes, process of route discovery speed up so as to decrease routing overhead.

Route Maintenance: It is carried out through acknowledgements and route error messages in a wireless networks. When a packet is forwarded towards the next hop, using source route cache, the node which is transmitting the packet is responsible for confirmation of data flow over the link. Acknowledgements are usually provided to confirm that link is capable of carrying data or not. If no acknowledgement has been received, then the source node treats the link to the next-hop destination as “broken". It should remove that link from its Route Cache and should return a "Route Error" to each node that is sharing that link [4].

C. Ad-Hoc on Demand Distance Vector Routing (AODV)

AODV is reactive routing protocol that initiates route discovery only when a route is needed and maintain active routes only while they are in use. As in DSR protocol if density of nodes in the network increases, packet header size also gets increase, thereby, wasting bandwidth and so degrading the performance of the network. To improve this, AODV maintains routing tables at the nodes, so that data packets do not have to contain source address in the routes so as to procure Bandwidth.
In AODV, route is established same as in DSR through route discovery and maintenance processes. Some of the features of AODV are:

1. In AODV route table entries do have lifetimes but in DSR route cache entries do not have lifetimes and also the routes which are not used from long time are deleted [5].
2. AODV route packet uses sequence number which signifies that information is fresh so that loop formations does not occur.
3. Intermediate nodes can reply to the RREQ only if they have route to the destination whose corresponding destination sequence number is greater than or equal to that contained in the RREQ.
4. In route maintenance process, Hello messages are broadcasted to maintain the local connectivity of the network. And if in between the route link breaks, then RERR message is broadcasted so that that link will be deleted from route cache.

Thus AODV is classified as a pure on-demand route acquisition system, as nodes that are not on selected path do not maintain routing information or participate in routing table exchanges.

III. SIMULTION ANALYSIS METHOD AND RESULTS

Here by implementing NS2, the popular simulation tool, an analysis of the performance of Routing protocols has been carried out and compared to adjudge the performance of such routing protocols.

A. *Performance Analysis Method and Simulation Results*

The simulation environment adopted for simulation as well as to compare the three routing protocols, i.e., DSDV, AODV and DSR, has been NS2. Simulations have been carried out by keeping the number of nodes as 24 under varying Simulation time and the performance metric viz. End to End delay, Throughput and Packet Loss have been computed.

End to End Delay: It is defined as the time taken for a packet to be transmitted over a network from source to destination. It includes all the delays that are Transmission, Propagation, Processing and Queuing delay. This metric defines the packet delivery time: lower the end to end delay, better the performance of application [6].

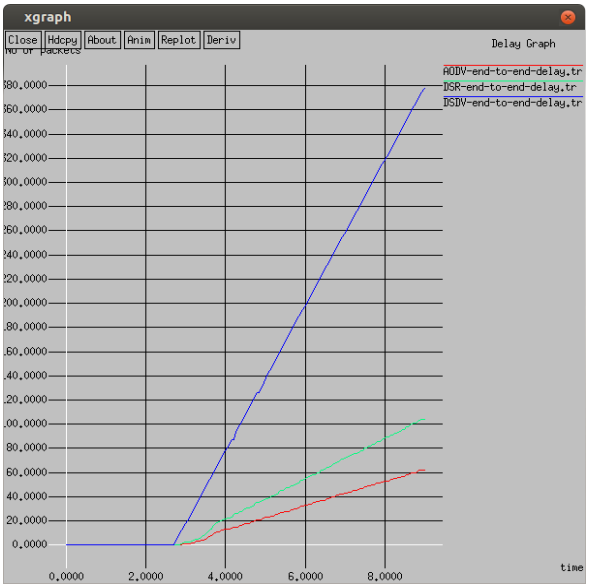

Fig.2. End to End Delay for AODV, DSR and DSDV

Figure 2 depicts the result for end to end delay when the simulation time is 9s. The computed values generated after simulation under varying simulation time of 12s and 15s have been indicated in Table 2.

Table.2. Comparison based on End to End Delay

Simulation Time	DSDV (no. of packets)	DSR (no. of packets)	AODV (no. of packets)
9 Second	370	100	60
12 Second	550	160	100
15 Second	770	200	120

From the values enumerated in Table 2, it has been observed that in comparison with DSR and DSDV protocols, lesser number of packets experience delay in AODV protocol and so AODV performs better than the other two protocols.

Throughput: It is the number of data packets arriving at the destination per millisecond [8].

Figure 3 shows us the result for throughput when the simulation time is 9s. The simulation under varying simulation time of 12s and 15s has also been plotted and the computed values have been indicated in Table 3.

Table.3. Comparison based on Throughput

Simulation Time	DSDV (No. of packets per mille sec.)	DSR (No. of packets per mille sec.)	AODV (No. of packets per mille sec.)
9 Second	125	150	250
12 Second	155	220	370
15 Second	240	280	480

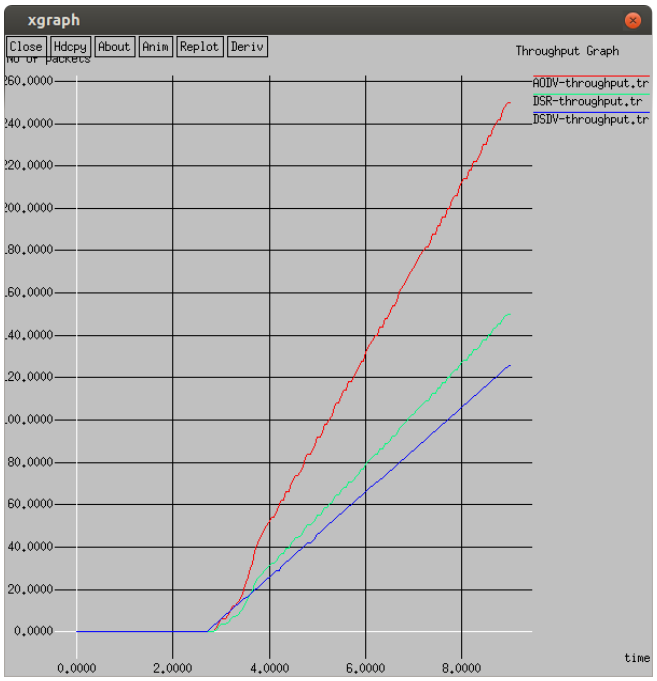

Fig.3. Throughput for AODV, DSR and DSDV

From Figure 3, it has been observed that in case of DSDV, lesser number of packets is generated with respect to time in comparison with AODV and DSR protocols and so it is having the better performance. It has further been observed that as the number of packets and simulation time is increased, AODV protocol throughput metrics is more in comparison with the other two.

Packet Loss: It occurs when data packets sent by the source are not delivered to the destination successfully.

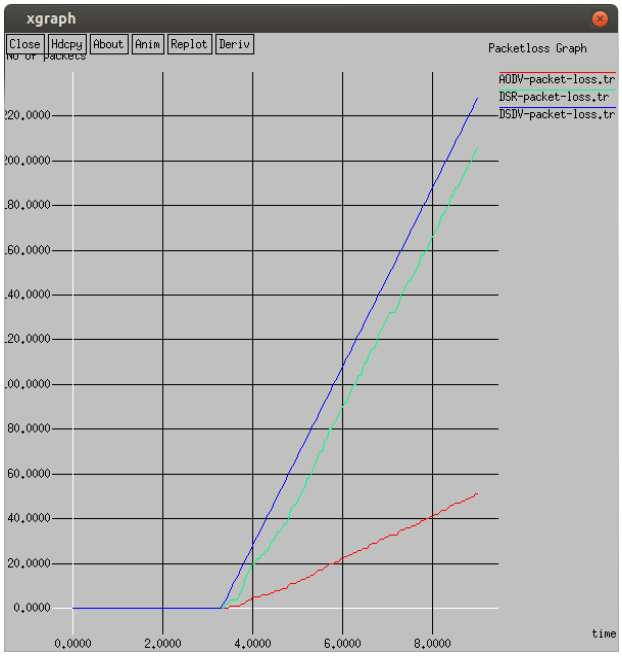

Fig.4. Packet loss for AODV, DSR and DSDV

In Figure 4, the result for packet loss for simulation time is 9s has been plotted and the simulation has also been carried out for varying simulation times of 12s and 15s and the computed values have been indicated in Table

Table.4. Comparison based on Packet Loss

Simulation Time	DSDV (No. of Packets)	DSR (No. of Packets)	AODV (No. of Packets)
9 Second	220	205	50
12 Second	340	320	80
15 Second	430	445	105

From the table it is observed that in case of AODV protocol the packet losses are quite lesser than other two protocols. It has further been observed that as the simulation time is increased to 15 seconds, the packet losses occur more in DSR as compared to DSDV protocol.

IV. PROPOSED TECHNIQUE TO IMPROVE ROUTING PROTOCOL

From the above simulation results, it has been analyzed that AODV Protocol provides a better performance as compared to other protocols used for comparison. To suggest an improvement in AODV protocol so that problem of routing the packets securely and efficiently in wireless networks is resolved [11], the following steps could be adopted:

1. Firstly by considering a finite number of nodes to form a network.
2. Now applying AODV protocol for path Establishment in that network, where Route Discovery and Route Reply processes helps in establishing the best efficient path from source to the destination.
3. After applying AODV routing protocol, it could be improved by hybridizing the two Bio-inspired Techniques.

The Bio-inspired techniques that can be implemented to improve the AODV routing Protocol are:-

A. *Ant Colony Optimization*

ACO is inspired by the behavior of foraging ant colonies, this is an algorithm that is based on the behavior of the real ants in finding a shortest path from source to the food. This algorithm utilizes the behavior of the real ants while searching for the food. While moving from its nest to the food, it has been noticed that the ants deposit a certain amount of pheromone in its path. Again while returning, the ants are submitted to follow the same path marked by the pheromone deposit [13].

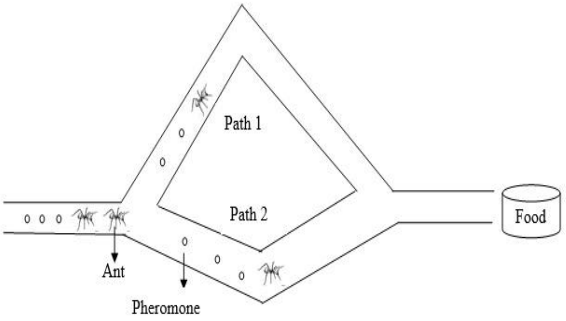

Fig.5. Ant Colony Optimization

Suppose that initially all the ants are in nest so there is no pheromone on the surface. When foraging starts, 50% of the ants follow the shortest path and other will follow the longest path. The ants that follow the shortest path reach earlier then the other which follows the longer. Since probability of choosing the shortest path is higher, the pheromone concentration increased on shortest path and due to evaporation of pheromone on longer path all the ants will start following the shortest path [14][15].

B. *Cuckoo's Search*

Because of the beautiful sounds they can make and also due to their aggressive reproduction approach, Cuckoos are known as captivating birds. This algorithm is inspired by the breeding behaviour such as obligate brood parasitism of cuckoo that lay their eggs in host bird nests. Brood Parasitism is feature of those organisms that depend upon others to raise their young ones. Some female parasitic cuckoos are often very specialized in the mimicry in color and pattern of the eggs of a few chosen host species. So that their eggs cannot by discover by the host bird and the eggs may easily hatched.

Cuckoo search is basically performed on the basis of following rules:

1. Cuckoo will lay one egg at a time and through it in a randomly chosen nest.
2. The nest with best eggs will take over to next generations.
3. The number of host nest is fixed. Egg laid by the cuckoo can be discovered by host bird with probability $P_a(0,1)$.So there will be two cases , first is the host bird can either get rid of the egg and second is the host bird simply evacuate the nest and build a completely new nest at the other location.

Cuckoo Search has many advantages due to its accessibility and efficiency in solving highly non-linear optimization problems with real-world engineering demands [16] [17].

V. CONCLUSION

In this paper, we reviewed the AODV, DSR and DSDV protocols and a comparison of the three routing protocols have been carried out by simulating through NS-2. The comparison has been performed on the basis of the parameters of end-to-end delay, throughput and packet loss and it has been concluded that for the ad-hoc network with constant number of nodes under varying simulation periods, in terms of packet delivery fraction and packet loss, AODV performs better in comparison to DSDV and DSR protocols. For throughput when the numbers of packets generated are lesser with respect to time, although DSDV performs better than the other two protocols but as the packets generation in the network is enhanced, AODV offers better results for similar number of nodes.

Thus as a whole, it has been concluded that AODV offers the best performance in comparison with the other two protocols and also has an ability to maintain the connection by periodic exchange of information. Therefore, to further improve the best routing protocol, i.e., AODV, a hybrid technique has been suggested that should be adopted in a network.

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