# Optimized Swarm based Dynamic Mobile Ad-Hoc on Demand Routing Network Protocol

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## ABSTRACT
A mobile adhoc network (MANET) is a collection of moving nodes in which nodes communicate without the use of any fixed infrastructure or any centralized domain. In such case a mobile host can behave both as a host and a router for forwarding data packets tor other mobile nodes in the network. As there is no fixed infrastructure therefore MANETs are considered to be vulnerable. Large overheads are required to maintain the routes regularly. Reactive protocols send control packets only during the communication. Dynamic Mobile Ad hoc Network On demand (DYMO) routing is one of reactive protocol which is proposed for the use by moving nodes in mobile ad hoc networks. It can easily adapt to the changing topology of network and can find routes between end nodes. This paper proposes the enhancement to the DYMO routing with the help of ant colony optimization (ACO). The enhanced version of the protocol is compared with the other protocols of its category on the basis of various performance parameters. The new protocol performs better than other protocols of their category.

## Keyword
MANET, TORA, AODV, DYMO, A-DYMO, ACO

## 1. INTRODUCTION
An Ad-hoc network allows both the device to communicate directly with everyone. There are no communication and controlling the central Access Point [1]. Their networks are just clever to pass on with other Ad-hoc devices, they are not able to communicate with any Infrastructure devices or any other devices connected to a wired network. In addition, Ad-hoc type of security is less complicated compared to an Infrastructure type network. In ad-hoc mode, all types of node share data directly with other nodes, so that ad-hoc network has no access point control is required. If ad-hoc network nodes can be same range of the network. This network has no physical infrastructure is desirable [2]. As no central coordination exists, we need to use decentralized MAC protocols such as CSMA/CA, with all nodes having the same functionality. This shoots up the convolution and outlay. Bluetooth is an archetypal ad-hoc network. Mobile ad-hoc Network (MANET) are an example of Infrastructure less networks. MANET is able to form an independent multi hop radio network. Intermediate nodes in Mobile ad-hoc Network can behave as a router and forward the packets to other nodes.

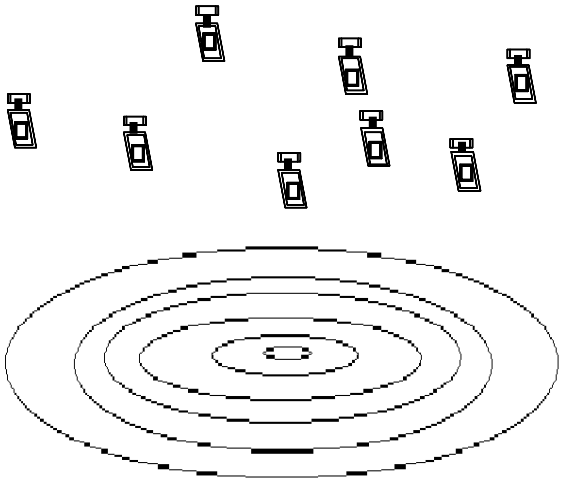

**Fig: 1 Mobile ad-hoc Network**

MANET has a self-forming nature and to manage among rapid changes of the topology [3].

## 2. ANT COLONY OPTIMIZATION (ACO):
Ant Colony Optimization a well-known swarm intelligence advance. The main idea of the ant colony optimization is taken from the food searching foraging behavior of real ant colonies. Then the ants search for food on the way, the ants run from their nest and walk any there toward the food destinations [5]. An ant arrives at the meeting point and it has to choose which branch to go. While going, ants deposit a chemical substance named pheromone, which ants are able to sense, which marks the route taken and they are attracted to the marked paths.

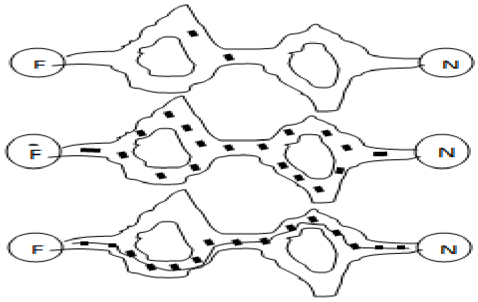


**Fig: 2 Ant Colony Optimization**

The more pheromone that is deposited on a path, the more attractive that path becomes. With time, the concentration of pheromone decreases due to volatile effects.

Evaporation clears the pheromone on longer paths as well as on less interesting paths. Shortest paths are refreshed more quickly with ants. There for ants motivation joins towards the nearly all efficient paths payable the detail that it gets the strongest attentiveness of pheromone. The shortest paths are best way for transmitted the network.

## 3. REACTIVE PROTOCOL

A Reactive protocol has a superlative routing protocol to soaring node's mobility for networks, the information's to transmit to nodes recurrently [6][7]. This protocol to send information then searches its route to the end node. So some example of routing protocols include the Ad Hoc On-Demand Distance Vector Routing Protocol (AODV), Temporally-Ordered Routing Algorithm (TORA) and Dynamic Manet on demand protocol (DYMO).

### 3.1 AODV

AODV used an on demand approach, AODV is a reactive protocol for finding the routes in the network. It protocol proposed for networks that can be surround thousands of nodes to source to destination [6]. Ad Hoc On-Demand Distance Vector is communally supported on the DSR and DSDV. The principles AODV employed at sequence numbers at the end to maintain the consistency of routing information. In the same way as in the DSR [7], the AODV uses a route demand in arrangeing to build a path to a certain destination. AODV used for two protocol operations: Route discovery and route maintenance. Every one node upholds a routing table that includes information regarding reaching a destination.

### 3.2 TORA

TORA means Temporary Ordered Routing Algorithm. Tora is anticipated for greatly dynamic, mobile and is a glowing structured algorithm. The scalability of TORA algorithm is very high and maintain still the network size increases. The nodes uphold routing information with reference to neighboring nodes. This TORA can hold routing in a very great network, messages are sent crossways the failed nodes only in anticipation of the control packets pass through [7]. Thus, unlike other protocols, in TORA the maintenance of broken links is done at that point itself and need not to start the route. The TORA protocol has three main occupations: Route creation, Route maintenance, and Route erasure.

### 3.3 DYMO

DYMO pass on Dynamic MANET On-Demand routing protocol, It that protocol is a a reactive routing protocol [8]. Ad-Hoc on-demand Distance Vector (AODV) routing protocol is based on DYMO algorithm. The DYMO routing protocol uses source routing on the way of networking. Its basic actions of DYMO are route discovery and route management [9][10]. DYMO uses sequence numbers to guarantee loop free.

### 3.4 A-DYMO

The DYMO protocol is being modified by adding the features of ACO. The control packets in DYMO are changed with the ant packets [11][12]. The new protocol is given the name of A-DYMO. Further to optimize the effect of flooding the distance factor and density factor are being considered. The ant packets are forwarded if they satisfy the both conditions of distance threshold and density criteria [13][14]. The following steps are used in devising the algorithm for the routing purpose:

Step 1: Forward ants (FANTS) are created at source node and send in the direction of the destination periodically. The FANT looks for a path towards the destination node by making use of the routing tables and chooses the next node $j$ with probability $(\Omega_{ij\,d})$ while making decision from node $i$ as:

$$\Omega_{ij\,d} = \frac{\rho_{ijd} + \theta\,\Gamma_{ij}}{\theta\,|N_i| + (1-\theta)} \quad \ldots(1)$$

$\rho_{ijd}$ is the pheromone value, $\Gamma_{ij}$ is a heuristic value which depends on the length of the $i-j$ th queue. $\theta$ is the weight of the heuristic value. The heuristic value $\Gamma_{ij}$ is calculated from the length of queue $l_{ij}$ and $|N_i|$ is number of neighbors:

$$\Gamma_{ij} = 1 - \left( \ell_{ij} \Big/ \sum_{i=1}^{|Ni|} \ell_{ij} \right) \quad \ldots(2)$$

Step 2: The FANTs are forwarded only if they satisfy the minimum distance threshold condition. The FANTs are only forwarded to the nodes who has distance less than the minimum threshold value. The distance (Dis) is calculated by the following equation between any node M and node N:

$$\mathrm{Dis} = \sqrt{(X_M - X_N)^2 + (Y_M - Y_N)^2} \quad \ldots(3)$$

The Dis is compared with a threshold value ( ThV ), if this value is less than ThV, then the FANTs are forwarded to that node. Otherwise that node is ignored for transmitting the FANTs.

If the number of neighboring nodes (nn) left by applying the distance formula are more than 3 then the broadcasting frequency is reduced to 80%. If the number of neighboring nodes are more than 5 then the broadcasting frequency is reduced to 60%. Further if the neighboring nodes are more than 7 or more then the broadcasting frequency if recuced by 50%.

$$\begin{cases} \text{if nn} > 3 \text{ and nn} \leq 5 \text{ then reduce broadcast frequency to } 80\% \\ \text{if nn} > 5 \text{ and nn} \leq 7 \text{ then reduce broadcast frequency to } 60\% \\ \text{if nn} > 7 \text{ or more then reduce broadcast frequency to } 50\% \end{cases} \quad \ldots(4)$$

The nn is compared with the density formula given above and broadcast frequency is adjusted according to the density value of the neighbor nodes.

Step 3: Each forward ant constructs a data structure while travelling which is in the form of a stack that appends the id of node traversed by it while making the trip.

Step 4: On reaching the destination node, the life of FANT is finished and a new ant called the backward ant (BANT) is created by inheriting the stack created by the FANT.

Step 5: The BANT extracts the stack and traverse the path in opposite manner of FANT by using the stack pop ups. The routing tables is updated by the BANT at each node traversal. The pheromone value is updated in the following manner:

If ( the node is traversed by the Ant) then

$$\rho(\mathrm{i}) = \rho(\mathrm{i}) + \mathrm{r} * (1 - \rho(\mathrm{i})) + \mathrm{r}^2 * \rho_{\mathrm{high}} / \mathrm{C} \quad \ldots(4)$$

else

$$\rho(\mathrm{i}) = \rho(\mathrm{i}) - \mathrm{r} * \rho(\mathrm{i}) - \mathrm{r}^2 * \rho_{\mathrm{high}} \,/\, (\,\mathrm{C} * (|\,\mathrm{N_i}\,| - 1))$$

.......(5)

Where $\rho_{high}$ is the highest pheromone value obtained in the present iteration. $C$ is the constant reliant on the simulation time. In our experiment, we have taken the value of $C$ as 1000 as we are doing all the calculations in milliseconds, $r$ is the dimensionless reinforcement factor between (0,1] and is calculated in a simpler manner as follows:

$$\mathrm{r} = \begin{cases} \dfrac{\mathrm{TrT}}{\mathrm{SF} * \mathrm{MeT}} \text{ if } \dfrac{\mathrm{TrT}}{\mathrm{SF} * \mathrm{MeT}} < 1 \\ 1 \text{ if } \dfrac{\mathrm{TrT}}{\mathrm{SF} * \mathrm{MeT}} \geq 1 \end{cases}$$

Where TrT id the total trip time taken by an ant, SF is the scaling factor between range of [1, 2] which is multiplied by the mean trip time MeT observed by the ant.

## 4. RESULTS AND SIMULATION

In order to validate the new routing protocol, the simulation work is carried out by using the network simulator (NS-2, Version: 2.35). Networks of 45 nodes were created. Similar network of 45 nodes were created for three more protocols, so that the performance metrics can be compared with each other. All the four protocols are simulated are results are extracted from their different trace files. The performance metrics used for comparing the results are average throughput, number of packets send, delivery ration, number of packets lost, average jitter and average end to end delay.

### 4.1 Number of Packets Send

This performance parameter is used to evaluate the strength of the protocol to deliver the maximum number of packets during the time of communication. The protocol which can deliver maximum packets in this category is considered to be better than other protocols. The above graph indicated that the A-DYMO can deliver more packets than other protocols. So, A-DYMO is considered superior than other protocols.

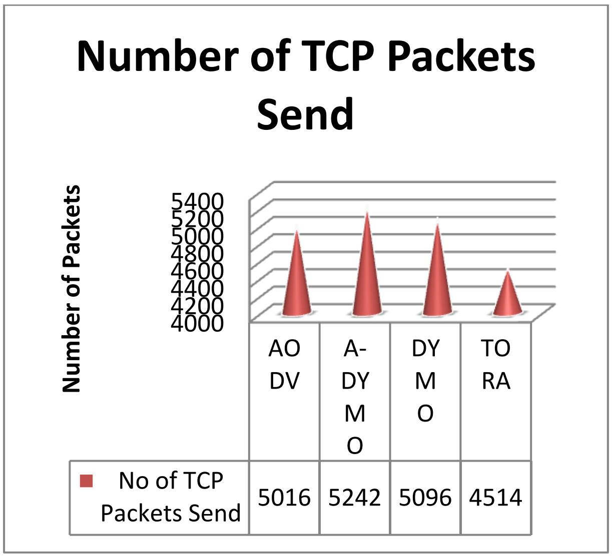


**Fig 4.1: Number of packets send**

### 4.2 Average Throughput

Average throughput is a measure of the ratio of number of packets delivered to the total time. It means it evaluates the delivery of packets in unit time.

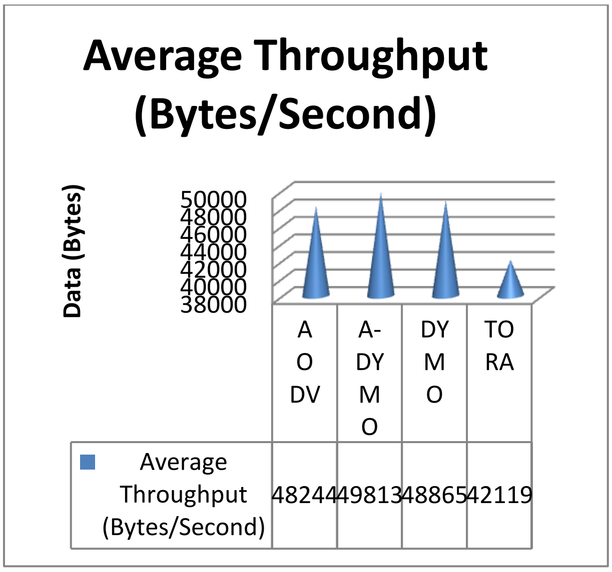


**Fig 4.2: Average Throughput**

The figure shown above clearly puts A-DYMO ahead of the other protocols used for comparison.

### 4.3 Number of Packets Lost

The packets are lost if protocol is unable to manage the route properly. A protocol which drops the lesser of packets during the communication is supposed to be better protocol.

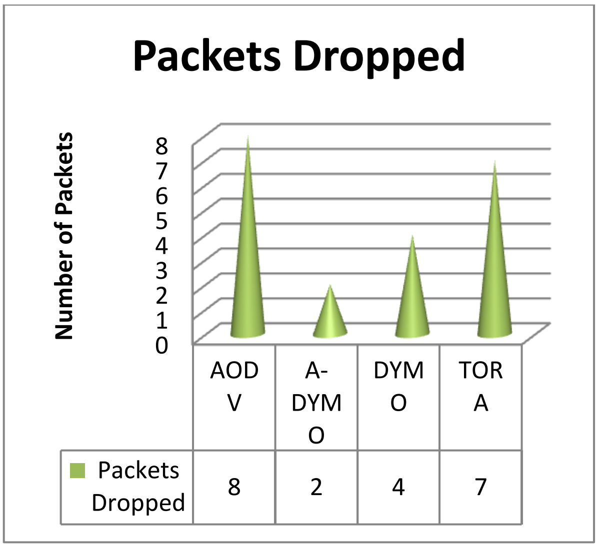


**Fig 4.3: Packets Dropped**

AODV performs worst in this category because larger number of packets are lost by it during communication. However least number of packets are dropped by A-DYMO as shown by figure above.

### 4.4 DELIVERY RATIO

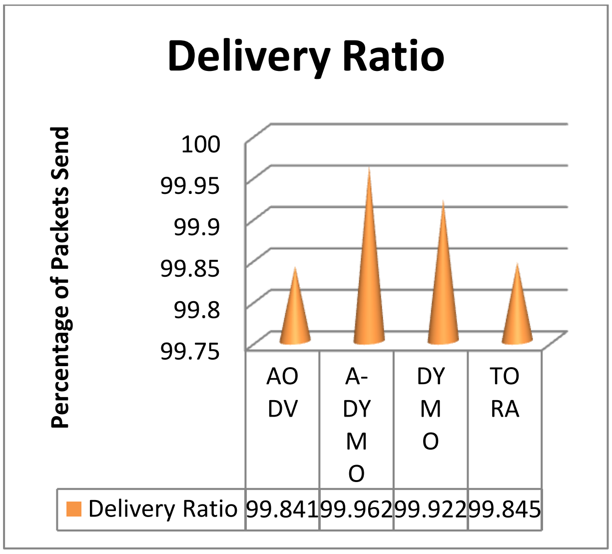


**Fig 4.4: Delivery Ratio**

This performance parameter is measured as the percentage of the successful delivered packets. The protocol having larger value in this parameter is considered to be a better protocol. A-DYMO again performs better in this category of parameter as it achieves better percentile than the other protocols.

### 4.5 AVERAGE JITTER

Jitter measures the fluctuations in delivery time observed by adjacent packets. The more the value of fluctuation, the worst the protocol is.

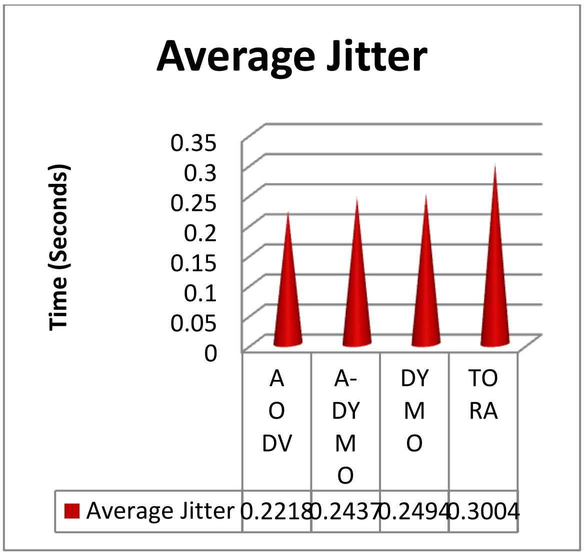


**Fig 4.5: Average Jitter**

So, this parameter should be minimized in order to achieve the better performance.

AODV performs better in this case whereas A-DYMO holds the second place while comparing the protocols on the basis of average jitter as shown in above figure.

### 4.6 AVERAGE END TO END DELAY

Delay is calculated as the time taken by the packet to reach the destination node from the source node.

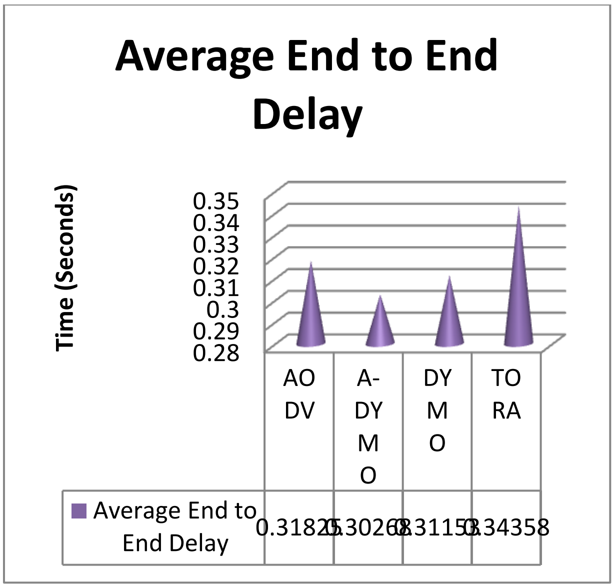


**Fig 4.6: Average End to End Delay**

Therefore, this parameter should have lower value because lower value indicates that the packet reaches the destination earlier. Again A-DYMO achieves better results in this category as the packets take less time to reach the destination. The graph in above figure also represent the success of new protocol.

## 5. CONCLUSION

MANETs do not have fix topology due to the movement of nodes. So, routing became a big challenge in MANET. Routing main aim is to deliver the data packets from one peer to other peer with the help ointermediate nodes. But, path is one of the main hurdle in adhoc networks. Moreover, to maintain path all the times is a major area of concern. In this paper we have concocted a new protocol by adding the swarm intelligence to DYMO protocol. In this paper, we have also worked on factors like distance from node and density of neighboring nodes. A new protocol is named as A-DYMO. The simulation is done using network simulator NS-2. Various parameters are used to compare the performance of new protocol with AODV, TORA and DYMO. Results of the new protocol are very encouraging and it overridesthe traditional protocols in almost all performance metrics.

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