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Congestion Control in MANETs Using PBO

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Abstract —

MANET became the focus of researchers as a promising technology for a broad range of applications due to their self-configuring & self-organizing capability in different networks. One important area of research within ad hoc networks is routing optimization. AODV routing protocol performs well routing for the mobile ad hoc network with high mobility. Nodes in MANET networks are mobile can generate routes randomly any where anytime. This needs a Routing optimization algorithm that balances routes among the nodes so that no congestion occurs among the nodes and the lifetime of the network is increased. In this paper, we are proposing PBO implemented AODV routing protocol to enhance the network lifetime and maintain the quality of service. In this the main focus is on congestion control to optimize the routing in manets using pollination based optimization. It helps to reduce the end to end delay, control bit ratio, packet delivery ratio and increase the average number of hops.

Keywords—
MANETs; AODV; Congestion; PBO;

I. INTRODUCTION

As the importance of computers increases, it also sets new demands for connectivity. Number of Solutions using Wired has been around for a long but there is increasing demand on working wireless solutions. Wireless communication between mobile users is growing more popular than ever before. This growth is due to the technological advancements in the field of computers and communicating devices. Technology has enabled computers and communicating devices (like laptops,wireless modems,tablets etc) to be equipped with radio interfaces to communicate. Wireless networking enhances the utility of carrying a computing device. It provides the mobile user with versatile and flexible communication and continuous access of networked services.

A mobile ad hoc network (Manet) is a group of mobile &wireless nodes which cooperatively form a network independent of any fixed infrastructure or centralized administration. In a particular, a Manet has no base stations, a node directly communicate with nodes within wireless range. Mobile Ad Hoc Networks (MANETs) represents the decentralized paradigms where clients themselves sustain the network in the absence of a central infrastructure. Nodes in Manet network are basically battery operated and thus have access to a limited amount of energy. Each device in a MANET is free to move independently in any direction, and therefore change their links to alternate devices. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. This type of networks may operate by them or may be connected to the larger Internet.

Features of MANET

- Rapidly deployable, self configuring.
- No need for existing infrastructure.
- Wireless links.
- Nodes are mobile the topology can change dynamically.
- Nodes must be able to cope with the traffic since communicating nodes might be out of range.

II. ROUTING PROTOCOLS IN MANETS

2.1 Reactive Protocols

Reactive protocols seek to set up routes on-demand. In this, if a node wants to initiate communication with a node to which it has no route then this routing protocol will try to establish such a route.

Pros and cons:

- Does not use bandwidth except when needed (when finding a route)
- Network overheads in the flooding process
- when querying for routes
- Initial delay in traffic

Examples:

- Admission Control enabled On demand Routing (ACOR)
- Ad hoc On-demand Distance Vector.
- Dynamic Source Routing (RFC 4728)
- Dynamic Manet On-demand Routing (RFC 4728)
- Power-Aware DSR-based

2.2 Proactive Protocols

A proactive protocol approach to MANET routing seeks to maintain a constantly updated topology. Whole of the network should be known to all nodes. It results in a constant overhead of routing traffic, but not any initial delay in communication.

Pros and cons:

- Constantly overheads are created by control traffic
- Routes are always available

Examples:

- B.A.T.M.A.N. – Better approach to mobile adhoc networking.
- Babel, a loop-avoidance distance-vector routing protocol RFC 6126.

2.3 Hybrid Protocols

Hybrid protocols are the protocols which combine the proactive and reactive approaches. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. The choice of method requires predetermination for typical cases.

Examples:

- ZRP (Zone Routing Protocol) ZRP uses IARP as pro-active and IERP as reactive component.

2.4 Ad-hoc On-demand Distance Vector (AODV)

The well known protocol which uses distance vector algorithm is Ad-hoc On-demand Distance Vector designed for MANET which is an updated version of DSDV protocol.

Routing Mechanism in AODV
Perkins et al [15] suggests that AODV uses DSDV mechanism for routing and consists of few key contents in the routing algorithm these are listed below,

- Sequence Number
- Route Request
- Route Reply
- Route Error
- Local Repair

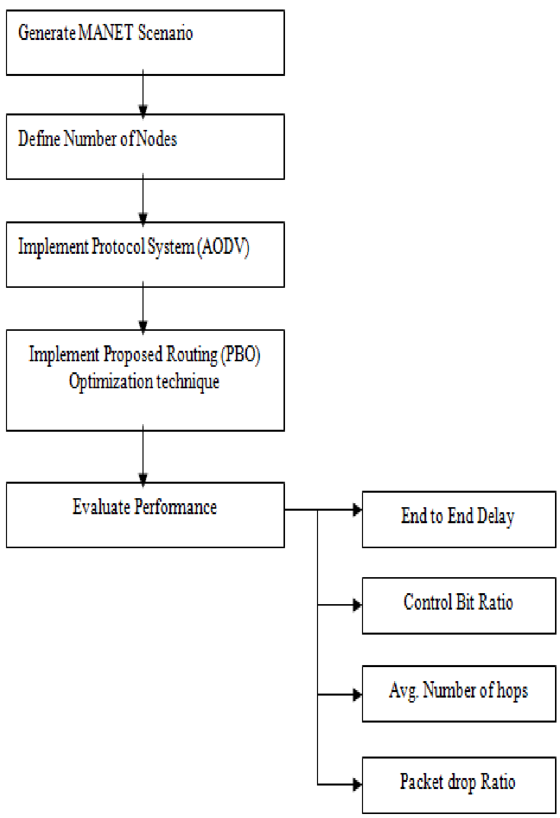
Advantages of AODV
AODV avoids the ``*counting to infinity*" problem from the classical distance vector algorithm by using sequence numbers for every route.

III. Routing Optimization using PBO

A Mobile Adhoc Networks (MANETs) is a collection of wireless nodes in which are autonomous in nature. MANET is a self configuring and self organizing collection of mobile nodes interconnected by wireless links. So, the topology of MANET changes rapidly and unpredictably. So, routing in MANETs is a very challenging task. Each and every routing protocol of MANET has its own characteristics and performance levels. So, it is very important to identify the most efficient routing protocol for a given scenario. As day by day, new technology advancements are taking place in MANETs, challenges are also increasing. Much of research for MANET’s routing protocols has been done on Constant Bit Rate (CBR), Transmission Control Protocol (TCP) traffic type.

Mobile ad hoc network is wireless network of mobile nodes without any centralized management and control. In this work, we present a protocol with an enhanced route discovery mechanism that avoids the congestion in the route. This protocol selects route on the basis of traffic load on the node and resets path as the topology changes.New efficient paths are discovered from time to time during transmission. This technique is efficient for transmissions that requires a link for longer period of time. In this work, we are going to enhance AODV protocol using Pollination based optimization algorithm to enhance route discovery mechanism that avoids the congestion in the route.

3.1 Basic Design of Proposed Work:



3.2 Proposed algorithm:

The proposed algorithm to solve the congestion problem by using routing optimization with the help of artificial intelligence technique named as pollination based optimization. This algorithm is based on the flowers/pollen gametes. In this work, we define these flowers as a number of nodes in the network scenario and performing the optimization. The proposed algorithm is defines below:

- Initialize network parameters:
  Area= 500*500;
  No. of nodes=30(n);
  a =1.2, A=0.9, D=1.2, N=0.9, P=2;
- Initialize a population of 'n' no of nodes says as pollen gametes with random solutions.
- Find the best solution (j) in the initial population.
- Define switch probability [0, 1]
- While (t<max iterations)
  For i=1:n
  If rand <p
  Calculate R;

$$R = \left(\frac{A\times D}{\alpha+A\times D}\right) + \frac{\left(\frac{\alpha}{\alpha+A\times D}\right)\times N^P}{A^P+N^P} - C(N + D)$$

  Do global pollination using R

  Else
  Randomly choose the value
  Do
  Local pollination
  End if
  Evaluate new solution
  If new solutions are better, update them in the population
  End for
- Find the current best solution(j)
- End while

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Where α → is a average display at average nectar content

A→ Average investment in nectar content of species, (A=optimum, N=0.9 (range 0.8 to 1.4)).

D→ Individual investment in Display (0 – 1.2, typical 1.2)

N→ Individual investment in nectar (0.8-1.5, typical 1.2 at A=0.9)

P→ Parameter related to pollinator learning efficiency.

$$P = m \times a + c$$

Where m & c are constants, (range 0.1-25, and typical .2)

C→ Proportionality constant relating investment to reproduction cost (1).

a=optimum, D=1.2

IV. Implementation

To implement this proposed solution we used Network Simulator 2. We test this proposed algorithm to different network scenario but here only discussed the scenario of 30 nodes with 500x500 areas. Manet scenario is generated by using NS-2 with this defined configuration using AODV protocol and comparison of AODV with PBO based routing is analyzed by using different network parameters. The network setup is defined below in table 1.

Table 1: Simulation Setup

Network Parameters	**Values**
Channel	Wireless
Radio propagation model	Two ray ground
Network interface type	Physical/wireless physical
MAC type	802_11
Interface Queue Type	Droptail/Priority queue
Link Layer Type	LL
Antenna Model	Omni Antenna
Queue length	50
No.of nodes	30
Routing protocol	AODV
Area	500*500
Simulation time	100s

Implementation in ns-2

NS-2 is used to simulate the real moving behaviours of the nodes in a mobile ad hoc network. The evaluation will be conducted with some specific number of nodes that will be randomly scattered in a specific region with specific number of connections. Figure 5.2 shows the MANET Environment generated by using NS-2.

Route request

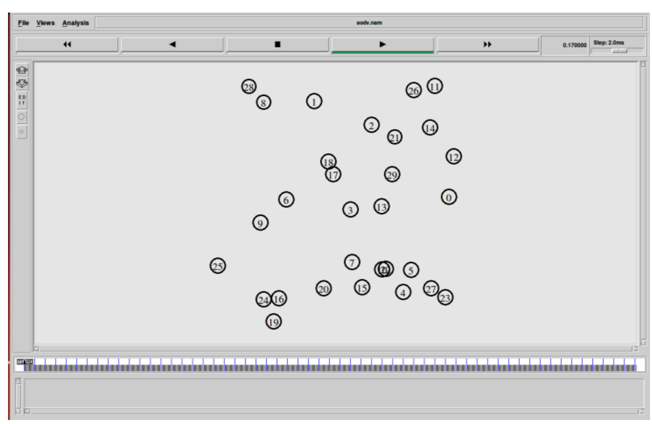

Figure 4.1 This shows how routes are requested in ns-2

Route discovery

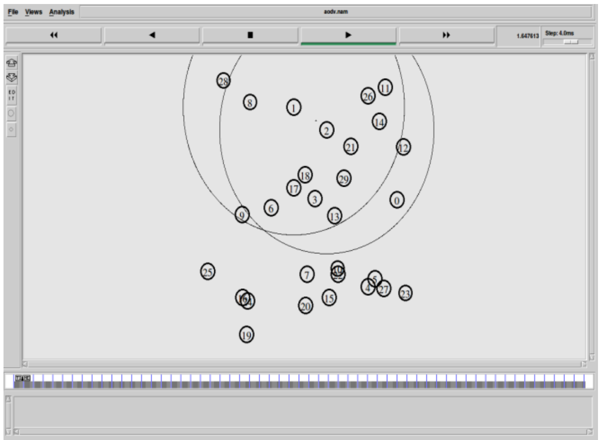

Figure 4.2 This shows how routes are discovered in ns-2

Packet transmission

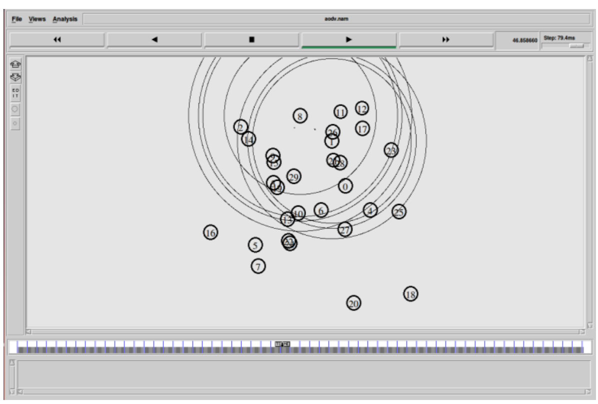

Figure 4.3 shows how packet can move or how data can be move from one node to another node by using NS-2.

5. Results & Discussion

To simulate the real moving behaviours of the nodes in a mobile ad hoc network a simulation tool will used. The evaluation will be conducted with some specific number of nodes that will be randomly scattered in a specific region with specific number of connections. This simulation evaluates the protocol using the following performance metrics:

a) Control Bit Ratio
b) Packet delivery Ratio
c) End to End Delay
d) Average Number of Hopes

Packet Sent: It is the number of packets sent by the application layer of source nodes.

Packet received: It is the number of packets received by the application layer of destination nodes.

Control Bit Ratio: Figure 5.1 shows the graph that represents the Control Bit Ratio of AODV & Enhanced AODV.

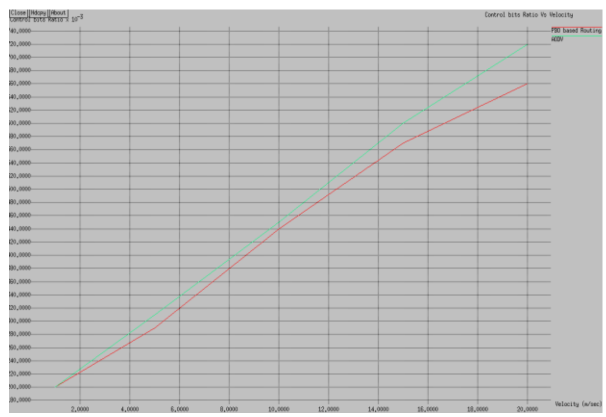

Figure 5.1:Graph is showing the value of control bit ratio

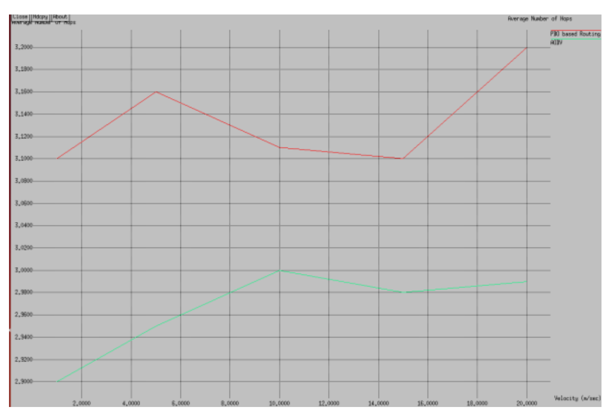

Figure 5.2:The average number of hopes is more in improved AODV

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Routing Overhead: The total number of routing control packets generated by all nodes to the total data packets during the simulation time.

Network Load: It is the total traffic received by the network layer from the higher MAC that is accepted and queued for transmission. It is measured as bits per second.

Packet delivery Ratio (PDR): It is the ratio of all the received data packets at the destination to the number of data packets sent by all the sources. It is calculated by dividing the number of packet received by destination through the no. of packet originated from the source.

$PDR = (P_r / P_s) * 100$

Where, P_r is total packet received and P_s is total packet sent.

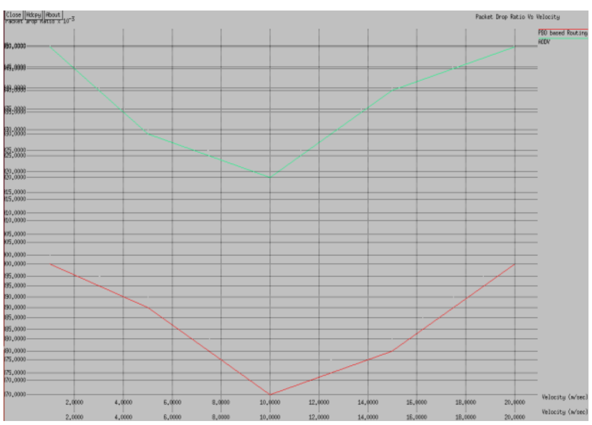

Figure 5.3:The packet delivery ratio is more in Improved AODV

End to End Delay: This includes all possible delays caused by buffering during route discovery, latency, and retransmission by intermediate nodes, processing delay and propagation delay. It is calculated as

$D = (T_r - T_s)$

T_r is receive time and T_s is sent time of the packet.

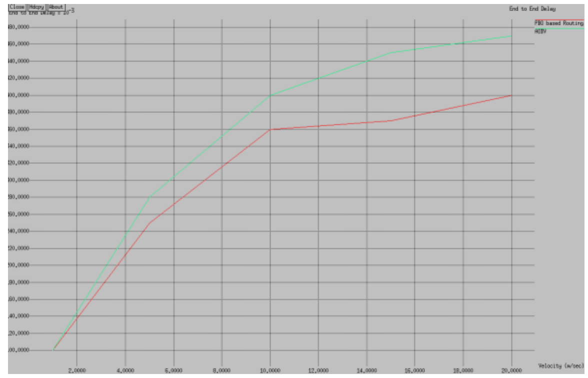

Figure 5.4:End to end delay is less in Improved AODV

V. Conclusion

Mobile Ad hoc network is network where nodes communicate without any central node or network. They are connected with wireless mediums and use various hops to change data. Routing protocols are used for communication and synchronization in such Ad hoc networks for timely delivery of message. In this work Route Optimization using PBO algorithm are used to maintain the quality of service and controlling congestion in MANET. The Evaluation of simulation results proves that improved PBO implemented AODV find the best route to the end node and it causes very much less contention in the channel and much lesser congestion in the network. When any node in the network is lost or got crowded by number of nodes the improved PBO implemented AODV protocol does not allow any node to interrupt its route and keep its packets safely transmitted over the network.

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