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MANET Routing Protocols with CBR and TCP Traffic using Improved Reference Point Group Mobility (iRPGM) Model

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Abstract
A mobile ad hoc network (MANET) is a collection of wireless mobile nodes forming a dynamic network Topology without the aid of any existing network infrastructure or centralized administration. Each node participating in the network acts as a host and as a router , means they have to forward packets and identify route as well. Random waypoint is the most common mobility model in most of the simulation based studies of various MANET routing protocols. The Group Mobility Model has been generated by Impact of Mobility Patterns on Routing in Ad-hoc Network (IMPORTANT). The present communication is an attempt to develop an improved version of Group Mobility Model named iRPGM, which provide the facility to assign number of nodes in a group according to demand. We have analyzed the Packet Delivery Ratio (PDR), Average End to End delay, Average Throughput, Normalized Routing Load (NRL) and number of Drop packets in CBR and TCP traffic model using reactive routing protocol, AODV and proactive routing protocol, DSDV . Research efforts have focused much in measuring their performance with unequal distribution of nodes in each group. Simulations has been carried out using NS-2 simulator
Keywords- *MANET, IMPORTANT, CBR, TCP, iRPGM, PDR, NRL, NS-2.*

1. Introduction

A Mobile Ad hoc Networks (MANET) represents a system of wireless mobile nodes that move arbitrarily and dynamically self-organize in to autonomous and temporary network topologies, allowing people and devices to seamlessly communicate without any pre-existing communication architecture. Such infrastructure less networks are usually needed in battlefields, disaster areas, and meetings, because of their capability of handling node failures and fast topology changes. The most important characteristics are dynamic topology, where nodes can change position quite frequently, so we require such routing protocol that quickly adapts to topology changes.

Normal routing protocol, which works well in fixed networks does not show same performance in Mobile ad-hoc Networks. In MANET routing protocols should be more dynamic so that they quickly respond to topological changes [1]. A number of protocols have been developed to accomplish this task.

Routing paths in MANET potentially contain multiple hops, and each node has the responsibility to act as router [2]. Routing in MANET has been a challenging task because of high degree of node mobility.

MANET routing protocol must have the following characteristics:

1) Keep the routing table up-to-date and reasonably small,
2) Select the best route for given destination and
3) Converge within an exchange of a small amount of messages [3].

There are several mobility models such as Random Way Point Model, Freeway Mobility Model, Manhattan Mobility Model and Reference Point Group Mobility Model (RPGM) and Gauss Markov Mobility Model etc.

Bindra, Maakar and Sangal[4] have studied performance evaluation of two reactive routing protocols of MANET using Group Mobility Model. In which they compare the performance of AODV and DSR with CBR and TCP traffic. In present paper, we have compared two routing protocols (AODV and DSDV) with CBR and TCP traffic with Group Mobility Model. PDR, Average End to End delay, Average Throughput, Normalized Routing Load and number of Drop packets has been evaluated as the function of Group and constant mobility speed..

This paper is organized in five sections. Section 2 gives brief description of studied routing protocols. Section 3 describes simulation environment, Reference Point Group Mobility (RPGM) Model, improved Reference Point Group Mobility (iRPGM) and performance metrics. Simulation results are discussed in section 4. Section 5 describes our conclusion and future scope.

2. Description of MANET Routing Protocols

Description of routing protocols AODV and DSDV in brief are as follows:

2.1. AODV (Ad-hoc On demand Distance Vector)

AODV[5] is a reactive protocol, which performs Route Discovery using control messages route request (RREQ) and route reply (RREP) whenever a node wishes to send packets to destination. To control network wide broadcasts of RREQs, the source node uses an expanding ring search technique. The forward path sets up an intermediate node in its route table with a lifetime association RREP. When either destination or intermediate node using moves, a route error (RERR) is sent to the affected source node. When source node receives the (RERR), it can reinitiate route if the route is still needed. Neighborhood information is obtained from broadcast Hello packet. As AODV protocol is a flat routing protocol it does not need any central administrative system to handle the routing process. AODV tends to reduce the control traffic messages overhead at the cost of increased latency in finding new routes. The AODV has great advantage in having less overhead over simple protocols which need to keep the entire route from the source host to the destination host in their messages. The RREQ and RREP messages, which are responsible for the route discovery, do not increase significantly the overhead from these control messages. AODV reacts relatively quickly to the topological changes in the network and updating only the hosts that may be affected by the change, using the RRER message. The Hello messages, which are responsible for the route maintenance, are also limited so that they do not create unnecessary overhead in the network. The AODV protocol is a loop free and avoids the counting to infinity problem, which were typical to the classical distance vector routing protocols, by the usage of the sequence numbers [6].

2.2. DSDV (Destination Sequenced Distance Vector)

The Destination Sequenced Distance Vector is a proactive routing protocol. Which include freedom from loops in routing tables, more dynamic and less convergence time. Every node in the MANET maintains a routing table which contains list of all known destination nodes within the network along with number of hops required to reach to particular node. Each entry is marked with a sequence number assigned by the destination node. The sequence numbers are used to identify stale routes thus avoiding formation of loops. In DSDV [7], each node have a routing table, here each table must contain the destination node address, the minimum number of hops to that destination and the next hop in the direction of that destination. The tables in DSDV also have an entry for sequence numbers for every destination. These sequence numbers form an important part of DSDV as they guarantee that the nodes can distinguish between stale and new routes. Here each node is associated with a sequence number and the value of the sequence number is incremented only by the node the sequence number is associated with. Thus, these increasing sequence numbers here emulate a logical clock. Suppose a node receives two updates from the same source then the receiving node here makes a decision as to which update to incorporate in its routing table based on the sequence number. A higher sequence number denotes a more recent update sent out by the source node. Therefore it can update its routing table with more actual information and hence avoid route loops or false routes.

DSDV determines the topology information and the route information by exchanging these routing tables, which each node maintains. The nodes here exchange routing updates whenever a node detects a change in topology. When a node receives an update packet, it checks the sequence number in the packet. If the information in the packet is older than the receiving node has in its routing tables, then the packet is discarded. Otherwise, information is updated appropriately in the receiving node’s routing table. The update packet is then forwarded to all other neighboring nodes (except the one from which the packet came). In addition, the node also sends any new information that resulted from the merging of the information provided by the update packet. The updates sent out in this case, by nodes resulting from a change, can be of two types that is either a full update or a partial update. In case of full updates, the complete routing table is sent out and in case of a partial updates only the changes since last full update are sent out.

3. Simulation Environment

The simulation is done with the help of NS-2 simulator version 2.34[8]. The network contains 30 nodes randomly distributed under 3, 4 and 5 groups in a 700m X 700m area with speed of 5m/s as basic scenario. The simulation time is 110s.

Table 1: Basic Simulation Scenario

Parameter	Value
No. of nodes	30
No. of Groups	2, 5
Protocols	AODV, DSDV
Simulation Time	110s
Speed Deviation	5m/s
Angle of Deviation	5 Degree
Traffic Type	CBR, TCP
Mobility Model	iRPGM
Packet Size	512byte
Wireless Range	250m
Area	700m X 700m

3.1. Reference Point Group Mobility (RPGM) Model

Group mobility can be used in military battlefield communication, where the commander and soldiers form a logical group. Here, each group has a logical center (group leader or commander) that determines the group’s motion behavior. Each member of the group (soldier) is uniformly distributed in neighborhood of group leader (commander). Subsequently, at every instant, each node has a speed and direction that is derived by randomly deviating from that of the group leader [9].

Each node derivates from its velocity randomly from that of leader. The movement in group mobility can be defined as follows:

$$| V_{member} (t) | = | V_{leader} (t) | + random () * SDR * max\_spee \text{ ……………………...(1)}$$

$$| \Theta_{member} (t) | = | \Theta_{leader} (t) | + random () * SDR * max\_angle \text{ …………………(2)}$$

Where 0 <= SDR (Standard Deviation Ratio) and ADR (Angle Deviation Ratio) <= 1.

SDR and ADR are used to control the deviation of the velocity of group members from that of the leader. Since the group leader mainly decides the mobility of group members, group mobility pattern is expected to have high spatial dependence for small values of SDR and ADR.

3.2. Improve Reference Point Group Mobility (iRPGM) Model

Generally, Reference Point Group Mobility (RPGM) model can be used with equal number of nodes assigned in all group. The Improved Reference Point Group Mobility (iRPGM) model is developed to assign equal as well as unequal number of nodes to each group.

The Algorithm for iRPGM Model is as follows:

```
Assume:
in_name, mobilenode as Two Dimension Dynamic Array
x as One Dimension Array
Current_Time,Simulation_Time, GROUP_NUMBERS, NODE_NUMBERS, A as Integer
SPEED_DEV, ANGLE_DEV as Real
Let:
Simulation_Time = 110 //second
A= 0 // Initialize by zero
Begin:
GROUP_NUMBERS = input("Number of Groups")
FOR I = 1 To GROUP_NUMBERS
    x [I] = input("Number of node in Group")
NEXT I
SPEED_DEV = input("Speed of Deviation")
ANGLE_DEV = input("Angle of Deviation in degree")
ANGLE_DEV = ANGLE_DEV / 2.314 * 180
FOR I = 1 To GROUP_NUMBERS
    n_name [I] = input ("Reference Point trace file for Group")
NEXT I
FOR I = 1 To GROUP_NUMBERS
    FOR J = 1 To X[J]
        mobilenode [I][J].initialize_node( ) and save in output trace file
    NEXT J
    A = A + X[I]
    NODE_NUMBERS = A
NEXT I
FOR Current_Time = 0 To Simulation_Time
    FOR I = 1 To GROUP_NUMBERS
        NODE_NUMBERS = x [I]
        FOR J = 1 To NODE_NUMBERS
            mobilenode [I][J].update_node( ) and save in output trace file
        NEXT J
    NEXT I
NEXT Current_Time.
End.
```

3.3. Performance Metrics

In present performance metrics, that we have been used for performance evaluation of ad-hoc network protocols. The following metrics are applied to comparing the protocol performance. These metrics are suggested by MANET working group for routing protocol evaluation [10].

Average Throughput: The sum of the data packets generated by every source, counted by k bit/s.

Average End to End Delay: This includes all possible delays caused by buffering during routing discovery latency, queuing at the interface queue, and retransmission delays at the MAC, propagation and transfer times.

Packet Delivery Ratio: The ratio between the number of data packets originated by the "application layer" CBR sources and the number of data packets received by the CBR sink at the final destination [11].

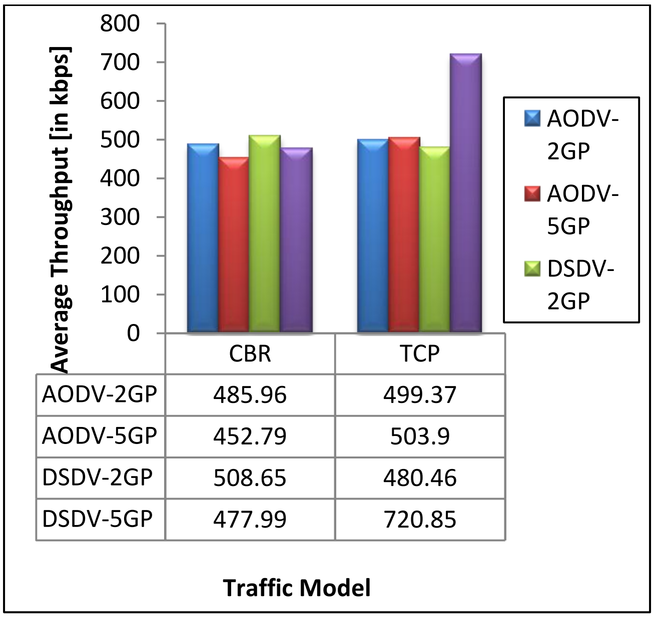
Normalized Routing Load: The sum of the routing control messages such as RREQ, RREP, RRER, HELLO etc, counted by k bit/s.

Number of Drop Packets: The number of the data packets originated by the sources failure to deliver to the destination.

4. Results

We have made an attempt to evaluate the performance of one reactive routing protocol, AODV and one proactive routing protocol, DSDV over 2 group (2gp), and 5 group (5gp) in a area of 700m X 700m with CBR and TCP traffic under Improved Reference Point Group Mobility Model (iRPGM). The results, which obtain are as discussed.

The Average Throughput with Traffic Type AODV and DSDV with 2 Group and 5 Group with CBR and TCP traffic are shown in the figure 1.

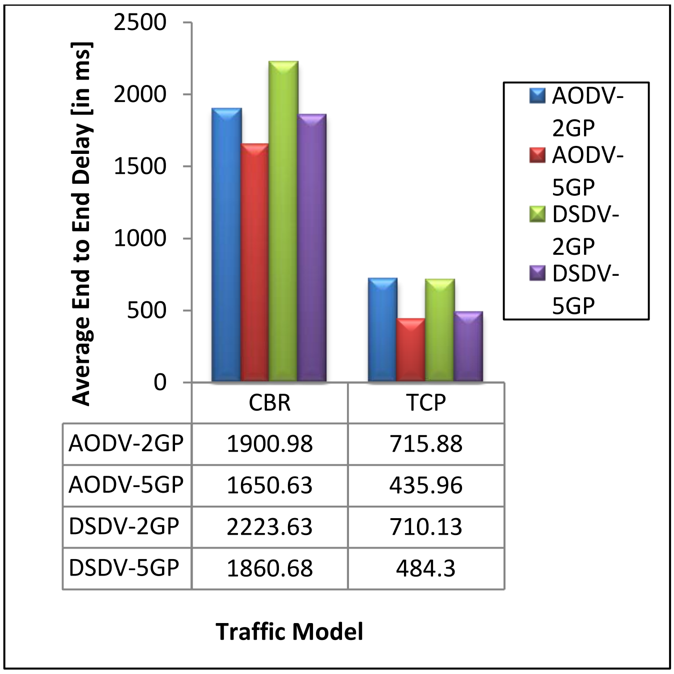


	CBR	TCP
AODV-2GP	485.96	499.37
AODV-5GP	452.79	503.9
DSDV-2GP	508.65	480.46
DSDV-5GP	477.99	720.85

Figure 1: Average Throughput with Traffic Type of AODV and DSDV with 2 and 5 Group

Figure 1 shows that Average throughput performance of both AODV and DSDV with CBR and TCP traffic. Average Throughput with CBR traffic is less than TCP traffic along with both the protocols. In CBR Traffic, Throughput is decreased with increasing group, while in TCP; Average Throughput is increased with increasing group. At TCP AODV perform well over the DSDV in terms of Average Throughput.

Figure 2 shows that Average End to End Delay performance of AODV and DSDV with CBR and TCP traffic in 2 Group and 5 Group. The Average End to End Delay with CBR traffic is much more than the TCP Traffic. In CBR traffic, AODV perform well over the DSDV because it has less value.



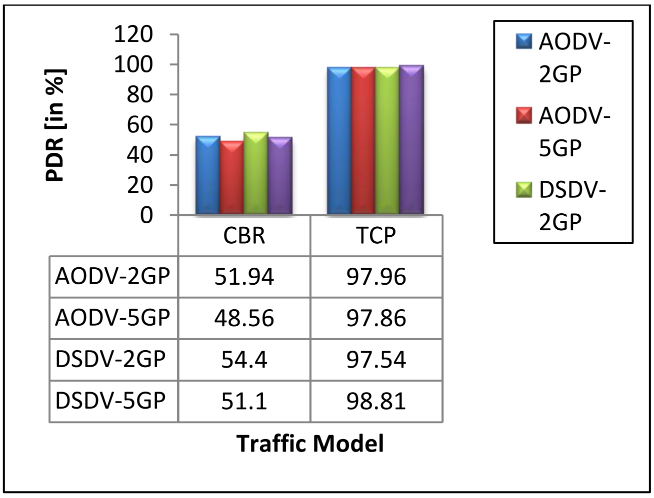
	CBR	TCP
AODV-2GP	1900.98	715.88
AODV-5GP	1650.63	435.96
DSDV-2GP	2223.63	710.13
DSDV-5GP	1860.68	484.3

Figure 2: Average End to End Delay with Traffic Type of AODV and DSDV with 2 and 5 Group

In TCP traffic, Average End to End delay of DSDV is less than AODV with all groups, so DSDV perform well over the AODV. In Both the traffic types, Average End to End Delay is decreased with increment in group.

The Packet Delivery Ratio (PDR) with Traffic Type of AODV and OLSR with 2 Group and 5 Group are shown in the figure 3, which shows that Packet Delivery Ratio (PDR) of both AODV and DSDV with CBR Traffic is decrease with increment in group, while Packet Delivery Ratio (PDR) of both AODV is slightly decrease and DSDV is slightly increase with TCP Traffic with increment in group. In CBR Traffic, the Packet Delivery Ratio of DSDV is better than AODV. In TCP Traffic, the Packet

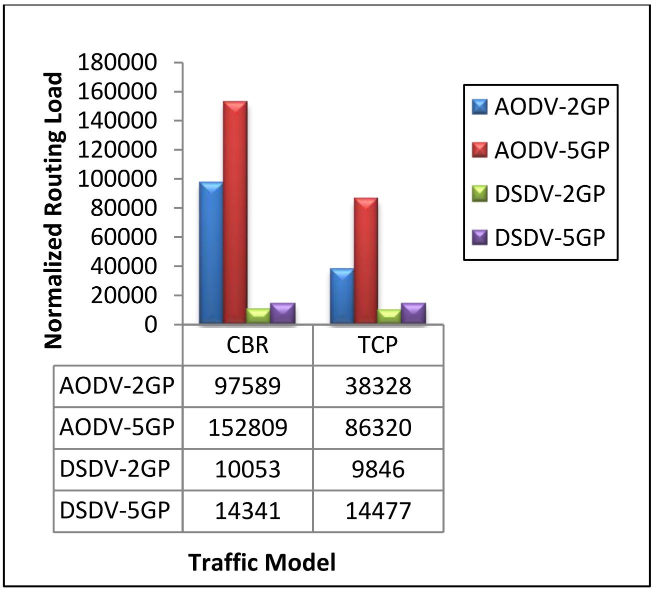
Delivery Ratio of DSDV is better than AODV with 5 group, while the Packet Delivery Ratio of AODV is better than DSDV with 2 group.



	CBR	TCP
AODV-2GP	51.94	97.96
AODV-5GP	48.56	97.86
DSDV-2GP	54.4	97.54
DSDV-5GP	51.1	98.81

Figure 3: Packet Delivery Ratio with Traffic Type of AODV and DSDV with 2 and 5 Group

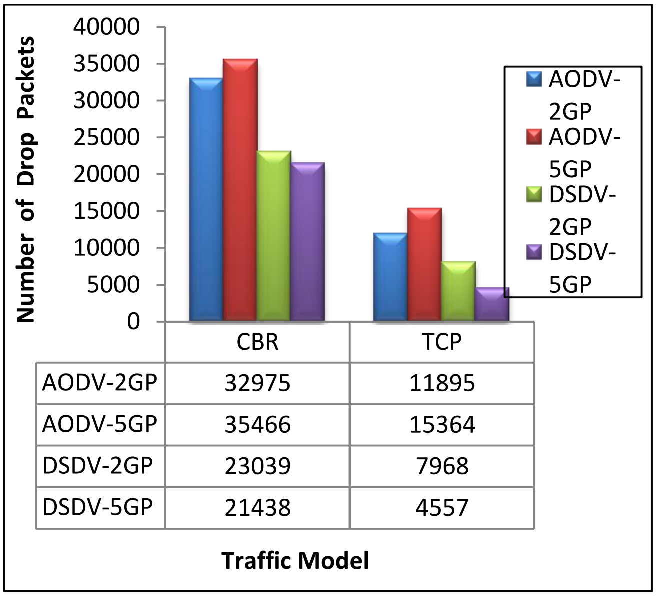
The Normalized Routing Load with CBR and TCP traffic of AODV and DSDV with 2 Group and 5 Group are shown in the figure 4.



	CBR	TCP
AODV-2GP	97589	38328
AODV-5GP	152809	86320
DSDV-2GP	10053	9846
DSDV-5GP	14341	14477

Figure 4: Normalized Routing Load with Traffic Type of AODV and DSDV with 2 and 5 Group

Figure 4 shows that Normalized Routing Load with both CBR and TCP traffic of AODV protocol is rapidly increased with increasing group, while Normalized Routing Load with DSDV protocol is slightly increased with increasing group. Normalized Routing Load of AODV protocol with both CBR and TCP traffic is high than DSDV protocol, thus DSDV performing well over AODV. The results indicate that MANET routing protocol perform well with TCP in comparison of CBR traffic.



	CBR	TCP
AODV-2GP	32975	11895
AODV-5GP	35466	15364
DSDV-2GP	23039	7968
DSDV-5GP	21438	4557

Figure 5: Number of Drop Packets with Traffic Type of AODV and DSDV with 2 and 5 Group

Figure 5 shows Number of Drop Packets with CBR and TCP traffic of AODV and DSDV with 2 Group and 5 Group. It shows that Number of Drop Packets in both AODV and DSDV protocol with CBR traffic is high than TCP. In TCP the number of Drop Packets is increased with increasing group for AODV, while the number of Drop Packets is increased with increasing group for DSDV. In both CBR and TCP Traffic the Number of Drop Packets in DSDV protocol is less than AODV protocol, means DSDV performs well over the AODV in terms of Number of Drop Packets due to less route discovery Process.

5. Conclusion and Future Scope

From the above simulation results, we observe that Average Throughput. Average Throughput with CBR traffic is less than TCP traffic along with both the protocols. In CBR Traffic, Throughput is decreased with increasing group, while in TCP;

Average Throughput is increased with increasing group. At TCP AODV perform well over the DSDV in terms of Average Throughput.

The Average End to End delay with TCP traffic, DSDV perform well over the AODV because it has less value. In CBR traffic, Average End to End delay of AODV is less than DSDV. In Both the traffic types, Average End to End Delay is decreased with increment in group. The Average End to End Delay with CBR traffic is much more than the TCP Traffic.

In CBR Traffic, the Packet Delivery Ratio of DSDV is better than AODV. In TCP Traffic, the Packet Delivery Ratio of DSDV is better than AODV with 5 group, while the Packet Delivery Ratio of AODV is better than DSDV with 2 group.

Normalized Routing Load of AODV protocol with both CBR and TCP traffic is high than DSDV protocol, thus DSDV performing well over AODV.

In both CBR and TCP Traffic the Number of Drop Packets in DSDV protocol is less than AODV protocol, means DSDV performs well over the AODV in terms of Number of Drop Packets due to less route discovery Process.

These results indicate that MANET routing protocol perform well with TCP in comparison of CBR traffic, when groups are formed by iRPGM model. In future we will try to evaluate and measure performance of these routing protocols with more number of groups under these scenarios and other routing protocol as well.

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