# Performance Comparison of TCP and CBR in MAODV Ad hoc Network

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## Abstract

Multicast Ad hoc On-Demand Distance Vector (MAODV) [1] is the multicast protocol associated with the Ad hoc On-Demand Distance Vector (AODV) [2,7] routing protocol, and as such it shares many similarities and packet formats with AODV. The Route Request and Route Reply packet types are based on those used by AODV, as is the unicast Route Table. The purpose of this paper is to compare the performance of TCP and CBR in MAODV Ad hoc network, where the efficiencies of TCP and CBR are evaluated in various parameters environment.

**Keyword:** MAODV, Ad hoc, performance

## 1. Introduction

The Multicast Ad hoc On-Demand Distance Vector (MAODV) protocol enables dynamic, self-starting, multihop routing between participating mobile nodes wishing to join or participate in a multicast group within an ad hoc network. The membership of these multicast groups is free to change during the lifetime of the network. MAODV enables mobile nodes to establish a tree connecting multicast group members. Mobile nodes are able to respond quickly to link breaks in multicast trees by repairing these breaks in a timely manner. In the event of a network partition, multicast trees are established independently in each partition, and trees for the same multicast group are quickly connected if the network components merge. One distinguishing feature of MAODV is its use of sequence numbers for multicast groups. Each multicast group has its own sequence number, which is initialized by the multicast group leader and incremented periodically. Using these sequence numbers ensures that routes found to multicast groups are always the most current ones available. Given the choice between two routes to a multicast tree, a requesting node always selects the one with the greatest sequence number.

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## 2. MAODV protocol description

Route Requests (RREQs), Route Replies (RREPs), Multicast Activations (MACTs), and Group Hellos (GRPHs) are the message types utilized by the multicast operation AODV. RREQs and RREPs. These message types are handled by UDP, and normal IP header processing applies. So, for instance, the requesting node is expected to use its IP address as the source IP address for the messages. The range of dissemination of broadcast RREQs can be indicated by the TTL in the IP header. Fragmentation is typically not required.

As long as the multicast group members remain connected (within a "multicast tree"), MAODV does not play any role. When a node either wishes to join a multicast group or find a route to a multicast group, the node uses a broadcast RREQ to discover a route to the multicast tree associated with that group. For join requests, a route is determined when the RREQ reaches a node that is already a member of the multicast tree, and the node's record of the multicast group sequence number is at least as great as that contained in the RREQ. For non-join requests, any node with a current route to the multicast tree may respond to the RREQ. A current route is defined as an unexpired multicast route table entry whose associated sequence number for the multicast group is at least as great as that contained in the RREQ. The route to the multicast tree is made available by unicasting a RREP back to the source of the RREQ. Since each node receiving the request caches a route back to the source of the request, the RREP can be unicast back to the source from any node able to satisfy the request. Once the source node has waited the discovery period to receive RREPs, it selects the best route to the multicast tree and unicasts the next hop along that route a MACT message. This message activates the route. Nodes monitor the link status of next hops on the multicast tree. When a link breaks on the multicast tree is detected, the tree branch should be immediately repaired through the use of the RREQ/RREP/MACT messages.

A multicast group leader is associated with each multicast group. The primary responsibility of this node is the initialization and maintenance of the group sequence number. A Group Hello message is periodically broadcast across the network by the multicast group leader. This message carries a multicast group and group sequence number and corresponding group leader IP address. This information is used for disseminating updated group sequence numbers throughout the multicast group and for repairing multicast trees after a previously disconnected portion of the network containing part of the multicast tree becomes reachable once again [1].

## 3. Simulation model

We use a detailed simulation model based on *ns-2* (ns 2.26) [6] in our evaluation by configure ns2.26 follow MAODV Implementation for NS-2.26 by Yufang Zhu and Thomas Kunz Systems and Computer Engineering Carleton University [3] include simulation environment but we provided performance comparisons of TCP and CBR.

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The simulation environment is:

1) Area: 1500 x 300 meters
2) Number of nodes: 50
3) Simulation duration: 910 seconds
4) Number of repetitions: 7
5) Physical/Mac Layer: IEEE 802.11 at 2Mbps, 250 meter transmission range
6) Mobility model: random waypoint model with no pause time, and node movement speed 0m/s, 1 m/s or 20 m/s.
7) Each receiver is a multicast group member [1], but each sender does not join a multicast group member except for the case with 50 receivers because all nodes are group members.
8) All receivers join a single multicast group at the beginning of the simulation, and the senders start sending data 30 seconds later. After 900 seconds, all senders stop transmitting data
9) CBR parameters: packetSize=256, interval=0.50, random=1 and maxpkts=1740
10) Only multicast traffic exists in the simulation.
11) All models have 1 sender 10, 20, 30, 40, 50 receivers; 2 senders 10, 20, 30, 40, 50 receivers; 5 senders 10, 20, 30, 40, 50 receivers; 10 senders 10, 20, 30, 40, 50 receivers

## 4. Performance metrics

1) Packet delivery fraction (PDF) - ratio of the data packets delivered to the destination to those generated by the TCP sources [5].
2) Average end to end delay (AEED) of data packets (Latency) - this includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, propagation and transfer times [5].

Each hop-wise transmission of a routing packet is counted as one transmission. The first two metrics are the most important metrics for best effort traffic. Note, however, that these metrics are not completely independent. For example, lower packet delivery fraction means that the delay metric is evaluated with fewer number of samples. In the conventional wisdom, the longer the path lengths, the higher the probability of a packet drop. Thus, with a lower delivery fraction, samples are usually biased in favor of smaller path lengths and thus have less delay. [4]

## 5. Performance Result

1) TCP and CBR: random waypoint model with no pause time, and node movement speed 0 m/s
2) TCP and CBR: random waypoint model with no pause time, and node movement speed 1 m/s
3) TCP and CBR: random waypoint model with no pause time, and node movement speed 20 m/s

### 5.1 Packet Delivery Fraction (PDF)

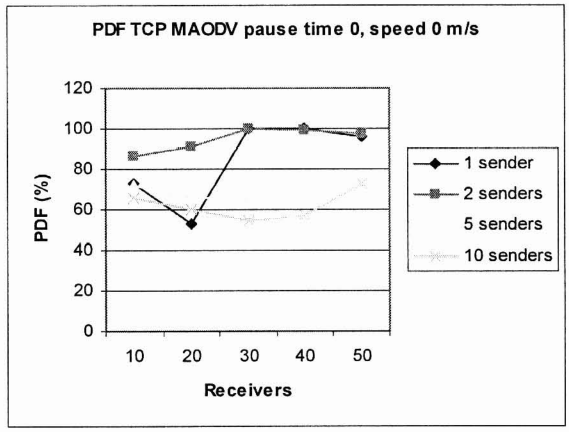


Fig. 1. PDF TCP MAODV, pause time 0, speed 0 m/s

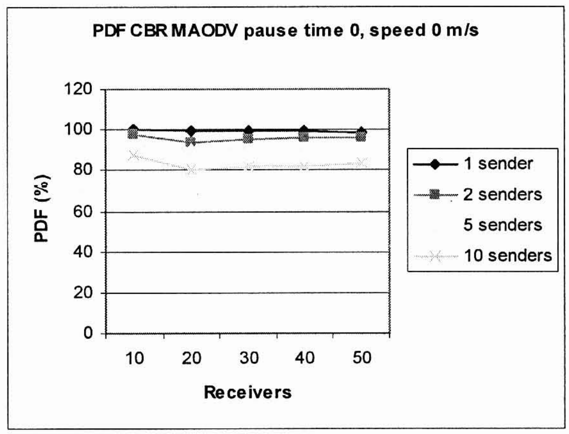


Fig. 2. PDF CBR MAODV, pause time 0, speed 0 m/s

From Fig 1, 2 are shown that PDF of TCP value range is 50 – 100% but PDF of CBR value is 80 – 100% with speed 0 m/s

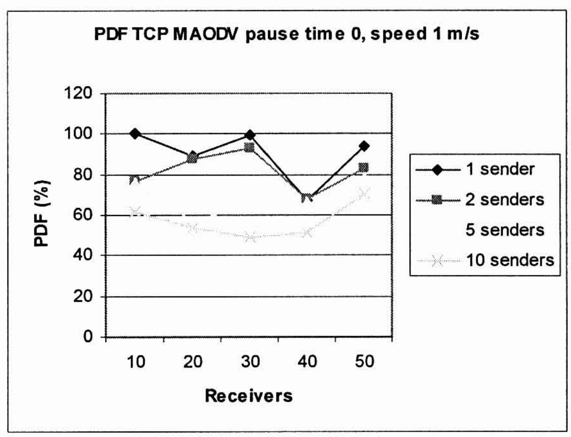


Fig. 3. PDF TCP MAODV, pause time 0, speed 1 m/s

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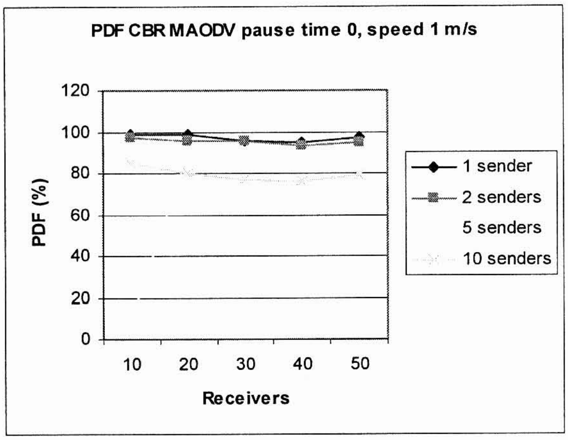


Fig. 4. PDF CBR MAODV, pause time 0, speed 1 m/s

From Fig 3, 4 are shown that PDF of TCP value range is 45 – 100% but PDF of CBR value is 70 – 100% approximately with speed 1 m/s.

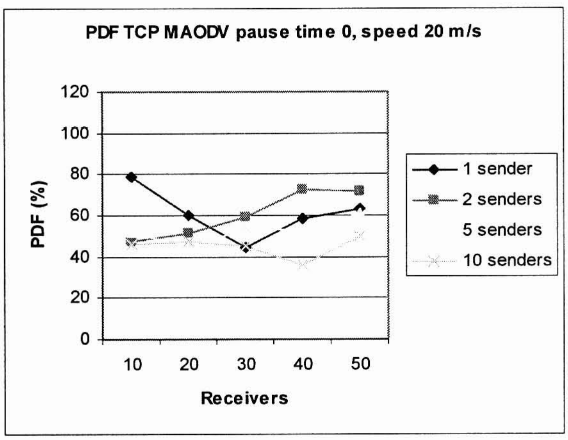


Fig. 5. PDF TCP MAODV, pause time 0, speed 20 m/s

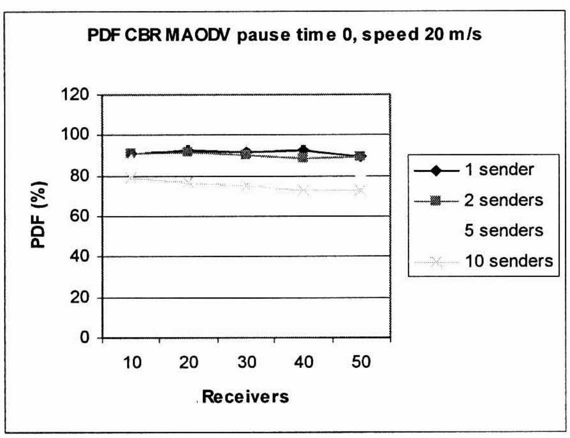


Fig. 6. PDF CBR MAODV, pause time 0, speed 20 m/s

From Fig 5, 6 are shown that PDF of TCP value range is 35 – 80% but PDF of CBR value is 70 – 90% with speed 20 m/s

## 5.2 Average End to End Delay (AEED)

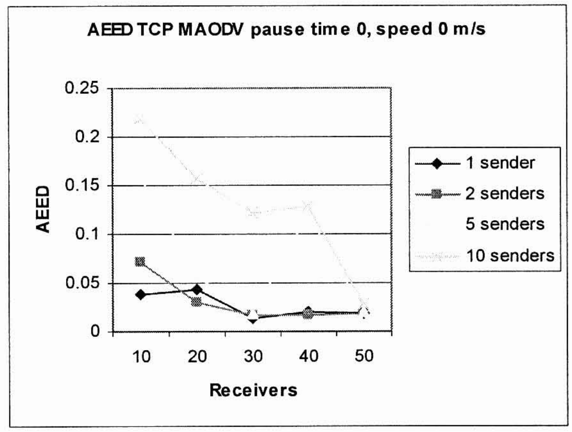


Fig. 7. AEED TCP MAODV, pause time 0, speed 0 m/s

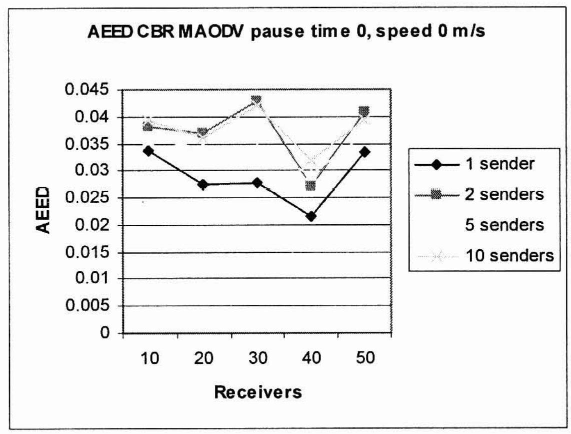


Fig. 8. AEED CBR MAODV, pause time 0, speed 0 m/s

From Fig 7, 8 are shown that AEED of TCP value range is 0.02 – 0.22 but PDF of CBR value is 0.02 – 0.045 with speed 0 m/s

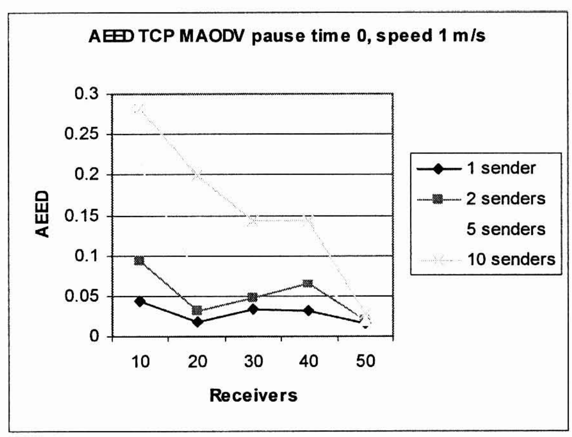


Fig. 9. AEED TCP MAODV, pause time 0, speed 1 m/s

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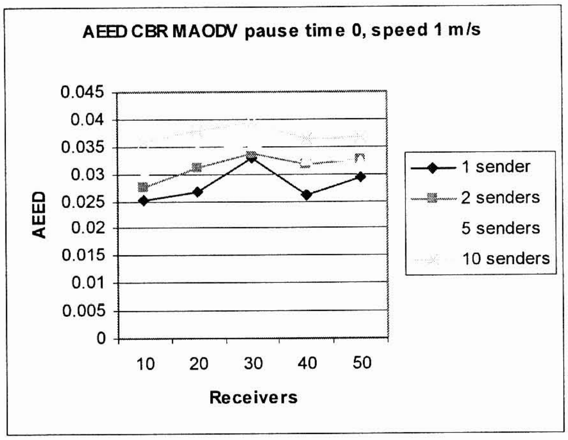


Fig. 10. AEED CBR MAODV, pause time 0, speed 1 m/s

From Fig 9, 10 are shown that AEED of TCP value range is 0.02 – 0.27 but PDF of CBR value is 0.025 – 0.04 with speed 1 m/s

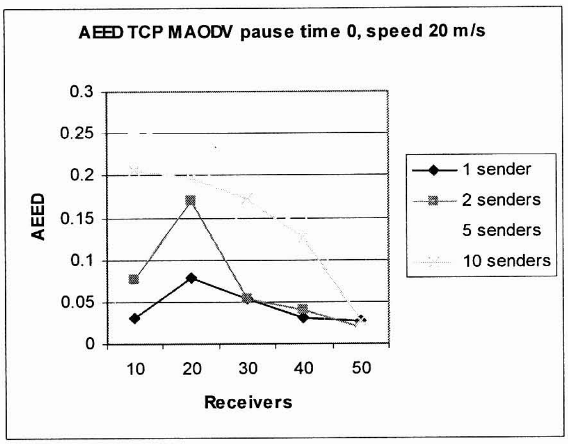


Fig. 11. AEED TCP MAODV, pause time 0, speed 20 m/s

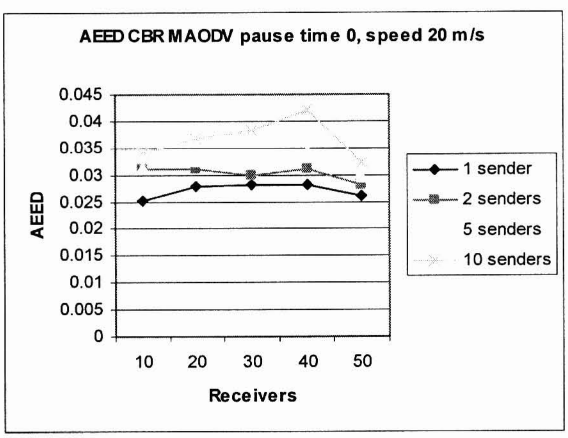


Fig. 12. AEED CBR MAODV, pause time 0, speed 20 m/s

From Fig 11, 12 are shown that AEED of TCP value range is 0.02 – 0.26 but PDF of CBR value is 0.025 – 0.042 with speed 20 m/s

# 6. Conclusion

The simulation results can be summarized as followings:

## 6.1 Packet Delivery Fraction (PDF)

- When we increase a numbers of the senders, the PDF values are decreased.
- When we increase a numbers of receivers, the PDF values are changed randomly.
- When we increase the speed of mobile nodes, the PDF values are decreased.
- The PDF variance of TCP is greater than the variance of CBR.
- The PDF mean of TCP is lower than the mean of CBR.

## 6.2 Average End to End Delay (AEED)

- When we increase a number of senders, the AEED values are increased.
- When we increase a number of receivers, the AEED values are changed randomly.
- When we increase the speed of mobile nodes, the AEED values are increased.
- The AEED variance of TCP is greater than the variance of CBR.
- The AEED mean of CBR is significantly lower than the mean of TCP.

With MAODV protocol, PDF and AEED values of CBR are better than TCP because TCP is a connection oriented. It creates a connection before sending the packets. It has the mechanism to guarantee that the packets will be delivered to the receivers. So when TCP is used in the scenario with many nodes' movements and multicasting, a number of receiving packets are decreased because it builds a connection before sending the packets every time. However, receiving packets are reliable and correct. On the other hand, CBR is considered a connection less, it does not create a connection before sending the packets, it sends the packets continuously and it does not guarantee the packets will be delivered to the receivers. For this reason, receiving packets using CBR is faster than TCP.

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