

Survey on Transmission Control Protocol Performance Over Different Mobile Ad Hoc Routing Protocols



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Abstract Mobile ad hoc network is an infrastructure-less network where the nodes are mobile and each node behaves as a router. There are many routing protocols in MANET which are used to govern the path from the source node to destination node. Many problems are associated with the MANET due to its wireless nature and the dynamic topologies, so this survey paper focuses on behavior of Transmission Control Protocol in reactive and proactive routing protocols of MANET which are DSDV, AODV, and DSR.

Keywords MANET · Transmission Control Protocol · DSDV
DSR · AODV

1 Introduction

Mobile ad hoc network (MANET) is an autonomous mobile node forming a network which is infrastructure-less [1]. Each node behaves as a router and is independent of moving in and out of the temporary ad hoc network which gives the MANET a dynamic nature. As it is a wireless transmission, there are several reliability issues.

Since there are many nodes present in the network, the path finding is done using Wireless Ad Hoc Routing Protocols which are of many types. This paper focuses on some of the routing protocols which are of types:

- (i) proactive and
- (ii) reactive.

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Proactive are the routing protocols in which each node maintains tables containing the information about the network. The table is updated which is initiated by a certain node or done in a certain interval of time. Destination-Sequenced Distance Vector Routing (DSDV) is an example of proactive routing protocols.

Reactive Routing Protocols are routing protocols in which table are not present containing the information of the network, the path is built when the source node requires to transmit packet. It is the bandwidth-efficient protocols as the load for maintaining the table is not present. Ad hoc on-demand distance vector routing protocol is an example of reactive routing protocol.

After the path from the source node to the destination node is found, then the process of delivering the packet is done using the transport layer protocols.

One such protocol is Transmission Control Protocol which provides the reliability, error control, flow control, and delivery of packets in order. TCP is one of the most used Internet protocols and carries approximately 90% of Internet traffic [2]. TCP must be independent of the underlying networks [3]; i.e., it can be used for both wired and wireless networks, but it has been proven that TCP gives good results in wired networks but it does not apply same for the wireless ad hoc network.

2 Congestion Control Mechanism in TCP

Many data are lost in the network due to the congestion of the network, so the TCP performs the congestion control mechanisms.

1. Slow Start [2–4]

The sender starts the session with congestion window value of maximum segment size (MSS). It sends one MSS and waits for the acknowledgment, and after the acknowledgment is received within the retransmission time-out (RTO), the sender again sends two MSSs and waits for acknowledgment. This doubling effect after receiving each acknowledgment is known as slow start.

2. Congestion Avoidance

The doubling effect continues till it reaches the slow start threshold, and then, it goes linearly. This linear growth takes one MSS for each acknowledgment, and it continues till the sender congestion size reaches the receiver congestion size, which is known as the congestion avoidance.

3. Fast Retransmit [2–4]

If it does not receive the acknowledgment within the RTO, then it assumes that the packet is lost in the network. TCP may generate the duplicate acknowledgment when an out-of-order segment is received. If three or more duplicate ACKs are received in a row, it is a strong indication that the segment is lost. It performs the retransmission of the lost segment known as fast retransmit. After fast retransmit

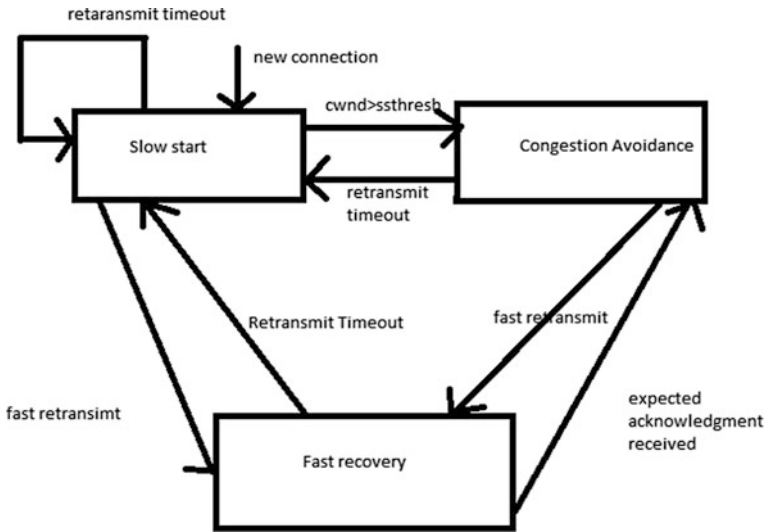


Fig. 1 Congestion control mechanism

sends the lost segment, then the congestion avoidance is performed without the slow start. This is the fast recovery process (Fig. 1).

3 Problems in MANET

(1) Frequent Path Breaks [2]

One of the main issues of the MANET is the node mobility and its velocity. Since the node is frequently moving and with a certain velocity, there are frequent path breaks. The path breaks make the TCP performance degrade and harder for the delivery of packets. It also complicates the routing protocols of MANET to find a path from the source node to the destination nodes.

(2) Lossy Channel [2, 3]

The errors in the wireless channels are caused due to:

(i) Signal attenuation

The strength of the signal reduces as it travels. Suppose P_s is the power of the transmitting source and P_d is the power of the receiving node and then:

$$P_s > P_d$$

It causes the quality of the signal to degrade with distance.

(ii) Doppler shift

It is the change of the wavelength caused due to the motion of the source. If there are three nodes A, B, and C and B is moving toward A and away from C, then A receives the signal with higher wavelength than C. It also degrades the quality of the signal.

(iii) Multipath fading

Suppose there are two nodes sender and the receiver, then a signal sent by the sender may reach the receiver by multiple paths and some of them may be due to reflection which may be received at a various interval of time. This will cause the problem with phase distortion intersymbol interference when data transmission is made.

(3) Power Constraint

The nodes that act independently as a router in the ad hoc topology have restricted power supply. This causes the power of the nodes to be utilized properly, and the wastage of the energy due to unnecessary transmission should be prohibited.

(4) Hidden and Exposed Node Problem

In hidden terminal, suppose there are three nodes A, B, and C as shown in Fig. 2, then a 'A' node tries to send the frame to B and at the same time C sends the frame to B and A is hidden from C, and there is a collision of frame at C [3].

In exposed terminal problem, suppose there are four nodes A, B, C, and D as shown in Fig. 3 and B is sending packet to A, the node C perceives as the channel is busy and does not send the packet to D. This causes the channel not to be utilized properly [3].

(5) Route Asymmetry

Since the nodes are mobile in the ad hoc topology, the path that is used for sending the packet and the path for sending back the acknowledgment may not be the same. Finding new path may be costly in terms of power consumption and delay in the delivery of packets [3].

Fig. 2 Hidden node problem

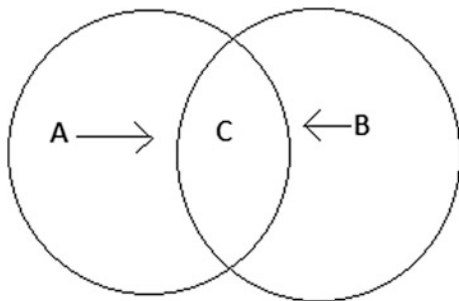
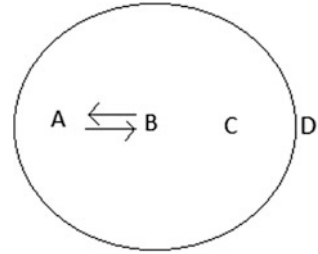


Fig. 3 Exposed node problem



4 Performance Matrices

Some of the performance metrics that can be used to evaluate TCP performance in ad hoc routing protocols are:

1. Packet delivery ratio: It is the ratio of number of packets received by the receiver and the number of packets sent by the sender.
2. Average delay: It is the delay between the time from when the data packet is given to the IP layer at the source node and the received time of the data packet by the IP layer of the destination.
3. Throughput: It is the number of packets successfully transmitted to the final destination per unit time [2].
4. Packet drop: It is the number of packets dropped when the receiver buffer is full [2].

5 Routing Protocols

Wireless ad hoc network has many routing protocols which can be classified into four categories:

1. Routing information update mechanism,
2. Use of temporal information for routing,
3. Routing topology, and
4. Utilization of specific resources.

This paper focuses on routing protocols of the routing information update mechanisms, which are reactive and proactive routing protocols. So the routing protocols are as such:

1. Destination-sequenced distance vector routing protocols (proactive)
2. Dynamic source routing protocols (reactive)
3. Ad hoc on-demand distance vector routing protocol (reactive)

1. Destination-Sequenced Distance Vector Routing Protocols (DSDV):

It is a proactive routing protocol which maintains the table containing the routing information. It is the improved version of the Bellman–Ford algorithm. Each node maintains a table which contains the shortest route and the neighboring node information through which we can reach that particular node. So the availability of routes makes this protocol to setup route with lesser delay. Table also contains the sequence number to remove the stale packets and the duplicate packets and to encounter the count to infinity problems. Tables are updated in a periodic manner or when a node observes that there is a significant amount of changes in the network [2, 5] (Fig. 4, Table 1).

2. Dynamic Source Routing Protocol (DSR):

It is a reactive routing protocol which means that it does not have route table. Due to the lack of route table, periodic update of the table is not required which reduces the utilization of the bandwidth. Route is established when it is required, and it is done by sending the route request packet which is broadcasted in the network. The intermediate node forwards the packet by checking the sequence number of the packets received and before the time to leave has expired. When the destination node receives the route request, it sends back the route reply in the reverse order of the path from where the route request came with the information that contains the path traversed by route request [1, 2, 5] (Fig. 5).

3. Ad Hoc On-Demand Distance Vector Routing Protocol (AODV):

It is a reactive routing protocol so route is established when required. The source node sends the route request packet to the intermediate nodes, and the source node and the intermediate node store the next hop information. The destination on receiving the route request sends back the route reply. The source node may get several route replies, so it uses the destination sequence number to get the up-to-date path to destination [1, 2, 5].

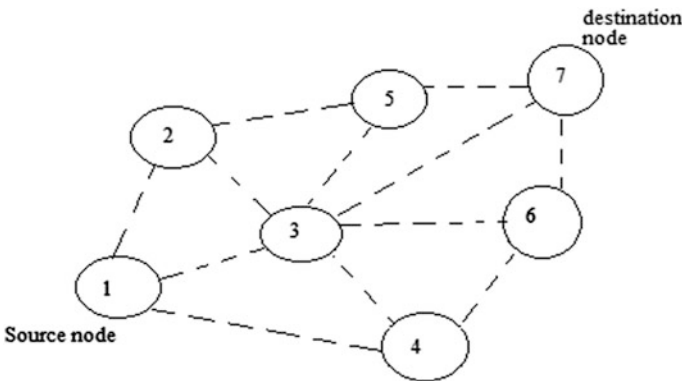


Fig. 4 Topology graph of the network

Table 1 Routing table for node 1

Destination	Next node	Distance	Sequence number
2	2	1	22
3	3	1	26
4	4	1	30
5	2	2	34
6	3	2	38
7	3	2	42

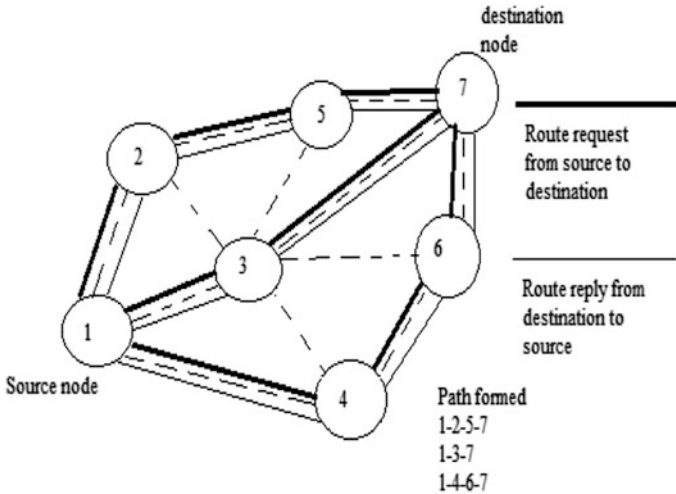


Fig. 5 Route establishment in DSR

6 Related Works

Noorani et al. [1] performed the analysis of two routing protocols, namely Ad Hoc On-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR) using the TCP Vegas with mobility consideration (Table 2).

The parameters used are packet delivery ratio and average end-to-end delay and found that AODV has highest packet drop and low average end-to-end delay using TCP Vegas. Furthermore, we can work on analysis of MANET environment under different issues such as node energy consumption, issues of hidden and exposed terminals, etc.

Chaudhary et al. [5] performed analysis of routing protocols such as AODV, DSR, DSDV under CBR and TCP traffic sources. The experimental results found that in CBR, if the traffic speed increases, the packet loss in DSDV goes higher than AODV and DSR. In TCP traffic, AODV has much higher packet drop than DSR and DSDV. So it shows that if the speed increases, load increases. The output of the

Table 2 Simulation parameters [1]

Variables	Values
Simulation time	300 s
Topology size	1000 m * 800 m
Total nodes	50
Mobility model	Random way point
Traffic type	TCP vegas
Packet rate	4 packets/s
Packet size	512 bytes
Maximum speed	20 m/s
Number of connections	10
Pause time	10, 100, 250, 450, 700
NS-2 version	NS2-2.8

simulation shows that reactive routing protocol in CBR traffic performed better than in TCP traffic.

Tabesh et al. [6] analyzed the throughput of two different TCP variants (Reno, Vegas) over two routing protocols AODV and DSDV in two environment dynamic and static topologies of area 1000 m * 1000 m with 50 number of nodes for MANET. It was found that the TCP Reno performed well than TCP Vegas. It was found that the throughput of the TCP reduced considerably when there was a link failure due to the mobility of the nodes and it could not differentiate whether the node failure was due to the congestion or due to the link failure. In this simulation, the only parameter used to see the performance of the TCP over routing protocols was the throughput, so other parameters can also be used to measure the performance in the future works.

Jain et al. [7] performed the analysis of the three routing protocols AODV, DSR, and DSDV using the two traffic types TCP and CBR in a fixed map size with the pause time (0, 10, 20, 50, 100, 200). In this simulation, the results showed that the overall performance of the on-demand routing protocols was better.

Gururaj et al. [8] performed the comparison of the two TCP variants HSTCP and Reno in MANET environment. It was found that the congestion window drop rate is less in case of HSTCP when compared to Reno. Window size changes more dynamically and sharply in case of HSTCP and leading to larger window size.

Samit Rout et al. [9] performed analysis of TCP connection in mobile ad hoc network considering different network sizes of 70, 50, 30 in an area of 1000 m * 1000 m. The routing protocols that used were AODV, DSDV, and DSR. After the simulation results, it was found that throughput of the TCP increase slowly with increase of connection till it reaches 20 TCP connection. Packet loss of AODV was found highest, routing overhead of the DSDV was highest, and throughput of AODV was better than other two protocols.

Dr. (Mrs) Saylee Gharge et al. [2] performed the analysis of TCP variants which are Tahoe, Reno, New Reno, Vegas, Westwood, WestwoodNR, SACK, and Fack in two scenarios: (i) wireless link failure were 6 mobile node were considered

Table 3 Output in wireless link failure

Parameter	TCP variant giving best output	Protocol giving best output
Throughput	WestwoodNR	AODV
End-to-end delay	Vegas	DSDV
Packet drop	WestwoodNR/Fack	DSR

Table 4 Output in signal loss scenario

Parameter	TCP variant giving best output	Protocol giving best output
Throughput	All variants	DSR
End-to-end delay	Vegas	AODV
Packet drop	All variants	DSR

(ii) signal loss scenario were 3 mobile node were considered. Four routing protocols were used: AODV, DSDV, DSR, and AOMDV. Performance parameters used were throughput, delay, packet loss (Tables 3 and 4).

7 Conclusion

TCP performance deteriorates in MANET due to several reasons stated above. It does not perform as efficient as wired networks. The major issue is to differentiate between the packet loss due to congestion and the packet loss due to link failure due to mobility of the nodes in the MANET [6]. The routing protocols also effect the TCP performance as seen in the survey papers that in most cases on-demand routing protocol AODV gave better throughput than table-driven routing protocols [5, 9]. Packet loss is higher in AODV which is a reactive protocol than DSDV. We cannot justify which protocol performs the better results by taking few parameters such as throughput, packet, and loss delay. It was seen that protocol like AODV gave higher throughput but with greater packet loss [2, 9], so we cannot abruptly come into conclusion that certain protocol is best suited for TCP.

References

1. Noorani RN (2009) Comparative analysis of reactive MANET routing protocols under the traffic of TCP VEGAS with mobility considerations. In: 2009 international conference on emerging technologies (ICET 2009). IEEE
2. Gharge S, Valanjoo A (2014) Simulation based performance evaluation of TCP variants and routing protocols in Mobile Ad-hoc Networks. In: 2014 international conference on advances in engineering and technology research (ICAETR). IEEE

3. Al Hanbali A, Altman E, Nain P (2004) A survey of TCP over mobile ad hoc networks. Diss. Inria
4. Dyer TD, Boppana RV (2001) A comparison of TCP performance over three routing protocols for mobile ad hoc networks. In: Proceedings of the 2nd ACM international symposium on Mobile ad hoc networking & computing. ACM
5. Chaudhary MS, Singh V (2012) Simulation and analysis of routing protocol under CBR and TCP traffic source. In: 2012 international conference on communication systems and network technologies (CSNT). IEEE
6. Tabash IK, Ahmad N, Beg S (2010) Performance evaluation of TCP Reno and Vegas over different routing protocols for MANETs. In: 2010 IEEE 4th international symposium on advanced networks and telecommunication systems. IEEE
7. Jain R, Khairnar NB, Shrivastava L (2011) Comparative study of three mobile ad-hoc network routing protocols under different traffic source. In: 2011 international conference on communication systems and network technologies (CSNT). IEEE
8. Gururaj HL, Ramesh B (2015) Congestion control for optimizing data transfer rate in mobile Ad-hoc networks using HSTCP. In: 2015 international conference on emerging research in electronics, computer science and technology (ICERECT). IEEE
9. Rout S et al (2014) Impact of multiple TCP connections in mobile ad-hoc network considering different network sizes. In: 2014 IEEE international conference on computational intelligence and computing research (ICIC). IEEE