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Performance Analysis of Different Routing Protocol with Different TCP Variants over Mobile Ad-hoc Network Using NS-2

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Abstract*—MANET is self independent, self organised and infrastructure less network with no fixed BS. The immediate mobile nodes between two nodes act as router to deliver the packets between them. So, MANET is a highly dynamic network. Mobile Ad hoc network routing protocols have been divided in several different categories such as Reactive and Proactive Routing Protocol. The performances of these categories are evaluated in different scenario with TCP variants. Several different variants have been developed in order to refine congestion control in Mobile Adhoc Networks. In this research, simulations were carried out by using Network Simulator-2 (NS-2) ,the selected MANET Routing protocols i.e. AODV, DSR and DSDV were analyzed in accordance with their finest performance of throughput under TCP, TCP NewReno, TCP Vegas, TCP Sack and TCP Westwood.The performance parameters on the basis of which routing protocols are graded is throughput.Conclusions are drawn based on the simulation results and the comparison results are graphically depicted and explained.

***Keywords*— MANET, NS-2 Simulator, Routing Protocols, TCP Variants**

I. INTRODUCTION

This Mobile Ad-hoc Networks (MANETs) are self–configuring, Infrastuctureless networks consisting of mobile nodes that are communicating through wireless links[1]. The nodes move arbitrarily; therefore, the network may experience unpredictable topology changes. Hence, it is said that an Ad-hoc wireless network is self -organizing and adaptive.

Most of the MANET applications make use of a reliable end to end transport protocol such as TCP include to set up an end to end connection for end to end delivery of data packets, flow control and congestion control[15].TCP has proved to perform reliably in traditional wired and stationary networks where the main reason for losses in network congestion but it does not perform as so when applied to wireless networks. It is because of the misinterpretation of the losses that are not caused by network congestion. Unfortunately it invokes a congestion control algorithm which reduces the bandwidth utilization and become the reason for performance degradation by providing poor throughput.

In MANETs, routing protocol can be classified into three categories; Proactive, Reactive and Hybrid routing protocol[16] .The pro-active routing protocols (Table-driven) are attempt to maintain consistent, up-to-date routing information of the whole network. Some of the existing pro-active ad hoc routing protocols are: Destination Sequenced Distance-Vector (DSDV), Wireless Routing Protocol, Cluster head Gateway Switch Routing, Global State Routing (GSR) ,Fisheye State Routing (FSR) , Hierarchical State Routing (HSR) , Zone based Hierarchical Link State and Source Tree Adaptive Routing. The Reactive routing protocols (On-demand) maintain only the routes that are currently in use, thereby trying to maintain low control overhead, reducing the load on the network when only a small subset of all available routes is in use at any time. Some of the existing reactive routing protocols are Ad hoc On-demand Distance Vector (AODV) Routing protocol, Dynamic Source Routing Protocol (DSRP), Associativity Based Routing (ABR) protocol, and Signal Stability Routing (SSR) protocol. Since the proactive and reactive routing protocols in MANETs have relative advantage and disadvantage, then evaluating and comparing them is very critical issue. Significant works has been carried out to evaluate and compare these routing protocols under various TCP Variants. Several different variants have been developed in order to refine congestion control in Mobile Adhoc Networks. These variants of TCP perform better under specific scenarios and these Variants are choosen for comparison because all work on different strategies. In this paper, the performance Analysis of AODV, DSDV and DSR routing protocols in MANETs using TCP Variants will be introduced using the NS2 simulator.

routing protocols.[3]

The rest of the paper is organised as follows. Section II presents different Ad-hoc Routing Protocol in MANET. Section III presents an brief introduction to TCP and TCP Variants. Section IV describes the Performance Metrics and Simulation Result. In Section V,Conclusion of the paper is given.

II. ROUTING PROTOCOLS IN MANET

The routing is the act of transferring information (packets) across a network from a source to a destination. The routing infrastructure needs to be established in a distributed, self- organized way due to node mobility.Topology-based routing protocols use the information about the links that exist in the network to perform packet forwarding.

Table Driven Routing Protocols (Proactive)

On-Demand routing Protocols (Reactive)
Hybrid Routing Protocols

A. Destination-Sequenced Distance-Vector (DSDV)

DSDV is a table-driven routing [17] scheme for MANETs. The Destination-Sequenced Distance-Vector (DSDV) Routing Algorithm is based on the idea of the classical Bellman-Ford Routing Algorithm with certain improvements. Every mobile station maintains a routing table that lists all available destinations, the number of hops to reach the destination and the sequence number assigned by the destination node. The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops.

B. Ad-hoc On-Demand Distance-Vector (AODV)

AODV routing protocol is an on demand routing protocol[56]. To find a route to the destination, the source node floods the network with RouteRequest packets. The RouteRequest packets create temporary route entries for the reverse path through every node it passes in the network. When it reaches the destination a RouteReply is sent back through the same path the RouteRequest was transmitted. Every node maintains a route table entry which updates the route expiry time. A route is valid for the given expiry time, after which the route entry is deleted from the routing table. Whenever a route is used to forward the data packet the route expiry time is updated to the current time plus the Active Route Timeout. An active neighbor node list is used by AODV at each node as a route entry to keep track of the neighboring nodes that are using the entry to route data packets. These nodes are notified with RouteError packets when the link to the next hop node is broken. Each such neighbor node, in turn, forwards the Route Error to its own list of active neighbors, thus invalidating all the routes using the broken link.

C. Dynamic Source Routing (DSR)

DSR is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad hoc networks of mobile nodes. [57]DSR allows the network to be completely self-organizing and self-configuring,without the need for any existing network infrastructure or administration. The protocol is composed of the two main mechanisms:
· Route Discovery
· Route Maintenance
Which work together to allow nodes to discover and maintain routes to arbitrary destinations in the ad hoc network. All aspects of the protocol operate entirely on demand, allowing the routing packet overhead of DSR to scale automatically to only what is needed to react to changes in the routes currently in use. The protocol allows multiple routes to any destination and allows each sender to select and control the routes used in routing its packets, for example, for use in load balancing or for increased robustness. Other advantages of the DSR protocol include easily guaranteed loopfree routing, operation in networks containing unidirectional links, use of only "soft state" in routing, and very rapid recovery when routes in the network change. The DSR protocol is designed mainly for mobile ad hoc networks of up to about two hundred nodes and is designed to work well even with very high rates of mobility.

III. BRIEF INTRODUCTION TO TCP AND TCP VARIANTS

A. Transmission Control Protocol [56]

Transmission Control Protocol, TCP is the Internet's most widely used transport control protocol. Its strength is in its adaptive nature of control algorithm and congestion avoidance, The TCP was first proposed by V. Jacobson. It was further refined in Reno version of TCP. The two major control mechanisms of TCP are its congestion control and congestion avoidance mechanism.

1) Slow Start: TCP estimates the bandwidth available before sending the data or else it would affect the throughput of TCP connection (throughput will decrease drastically). The reason behind this is that if the buffer gets full, the intermediate routers would drop the packets form the buffer. The Slow Start mechanism has a new parameter which is responsible to control the rate at which packets are sent, congestion window denoted by cwnd.

2) Congestion Avoidance: An algorithm used by TCP to avoid losing packets is known as Congestion Avoidance Algorithm. Congestion avoidance takes place when the value of cwnd becomes greater than ssthresh. In this phase, the cwnd is increased by one1full-sized segment every RTT. Congestion avoidance continues to run until congestion is detected. There aretwo ways to detect congestion one is receipt of duplicate acknowledgment and due to time timeout.

B. TCP Variants

TCP variants are used in this paper namely:

1) *New-Reno:* New RENO is a slight modification over TCP-RENO[14]. It is able to detect multiple packet losses and thus is much more efficient that RENO in the event of multiple packet losses. Like RENO, New-RENO also enters into fast-retransmit when it receives multiple duplicate packets, however it differs from RENO in that it doesn't exit fast-recovery until all the data which was out standing at the time it entered fast recovery is acknowledged. The fast-recovery phase proceeds as in Reno, however when a fresh ACK is received then there are two cases:
    - If it ACK's all the segments which were outstanding when we entered fast recovery then it exits fast recovery and sets CWD to threshold value and continues congestion avoidance like Tahoe.
    - If the ACK is a partial ACK then it deduces that the next segment in line was lost and it re-transmits that segment and sets the number of duplicate ACKS received to zero. It exits Fast recovery when all the data in the window is acknowledged

Problems:

New-Reno suffers from the fact that it takes one RTT to detect each packet loss. When the ACK for the first retransmitted segment is received only then can we deduce which other segment was lost.

2) *TCP SACK* : TCP with Selective Acknowledgments‘ is an extension of TCP RENO and it works around the problems face by TCP RENO and TCP New-RENO, namely detection of multiple lost packets, and re-transmission of more than one lost packet per RTT. [14]SACK retains the slow-start and fast retransmits parts of RENO. It also has the coarse grained timeout of Tahoe to fall back on, in case a packet loss is not detected by the modified algorithm. SACK TCP requires that segments not be acknowledged cumulatively but should be acknowledged selectively. If there are no such segments outstanding then it sends a new packet**.** Thus more than one lost segment can be sent in one RTT.

   Problems:

   The biggest problem with SACK is that currently selective acknowledgements are not provided by the receiver to implement SACK we‘ll need to implement selective acknowledgment which is not a very easy task.

3) *TCP Vegas:* Vegas is a TCP implementation which is a modification of RENO[17],. It builds on the fact that proactive measure to encounter congestion is much more efficient than reactive ones. It tried to get around the problem of coarse grain timeouts by suggesting an algorithm which checks for timeouts at a very efficient schedule. TCP Vegas Calculate the difference between the expected throughput and actual throughput rates to estimate the available bandwidth in the network[16].Also it overcomes the problem of requiring enough duplicate acknowledgements to detect a packet loss, and it also suggests a modified slow start algorithm which prevents it from congesting the network.

4) *TCP Westwood:* TCP Westwood (TCPW) congestion control algorithm [17] use a bandwidth estimation, it executed at sender side of a TCP connection. The congestion window dynamics during slow start and congestion avoidance are unchanged. The general idea is to use the bandwidth estimate BWE to set the congestion window (cwin) and the slow start threshold (ssthresh) after a congestion episode. In TCP Westwood the sender continuously computes the connection BWE which is defined as the share bottleneck used by the connection. Thus, BWE is equal to the rate at which data is delivered to the TCP receiver. The estimate is based on the rate at which ACKs are received and on their payload. After a packet loss, the sender resets the congestion window and the slow start. Threshold based on BWE. The packet loss is suspected with a reception of three duplicates ACKs or timeout expiration. Another important element of this procedure is the RTT estimation. That is because the congestion window is set precisely to BWE * RTT after indication of packet loss.

IV. PERFOMANCE METRICS AND SIMULATION RESULT

A. *Performance Metrics*

To compare some of the protocols , we need to consider some of the metrics for comparing the performance of these protocols.

- Throughput :

  Throughput is defined as the total size of useful packets that received at all the destination nodes in a unit time.

  Throughput of node A to B is:

$$\text{Throughput} = \frac{\text{No of Bits from node A to Node B}}{\text{Observation Duration}}$$

B. *Simulation Result*

The Simulation shows the 50 nodes and data transfer between these nodes. It also shows the X-graphs of throughput in simulation. Throughput is based on packet delivery between 50 nodes. The implementation is performed in NS2 and analysis is presented using X-graphs. In Fig. 1,2, 3,4 and 5 we show the comparison of different Routing Protocol AODV, DSDV and DSR with TCP and different TCP Variants respectively with the X-graph.

1) *TCP performance over AODV, DSDV & DSR with 50 nodes.*

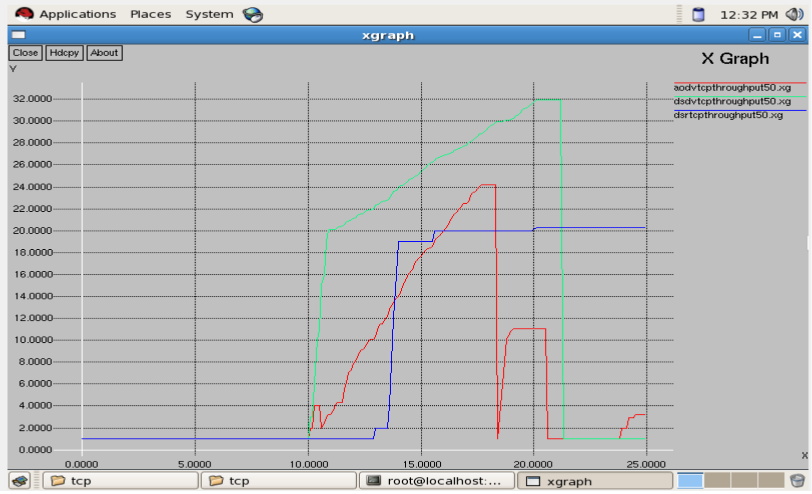

Figure 1: X-Graph representing comparison of throughput for TCP Simulation with 50 nodes in AODV, DSDV & DSR.

In fig. 1,Here we can clearly see throughput in case of DSDV with traditional tcp performs best as compare to AODV and DSR.

2) TCP New Reno performance over AODV, DSDV & DSR with 50 nodes

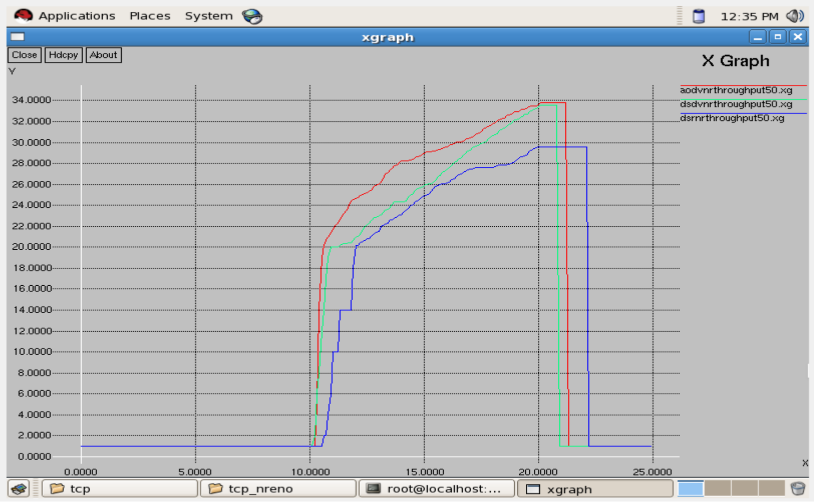

Figure 2: X-Graph representing comparison of throughput for TCP-NEWRENO Simulation with 50 nodes in AODV, DSDV & DSR.

In fig. 2,Here we can clearly see the throughput performance of AODV with TCP-NEWRENO is better than DSDV and DSR.

3) TCP-SACK performance over AODV, DSDV & DSR with 50 nodes

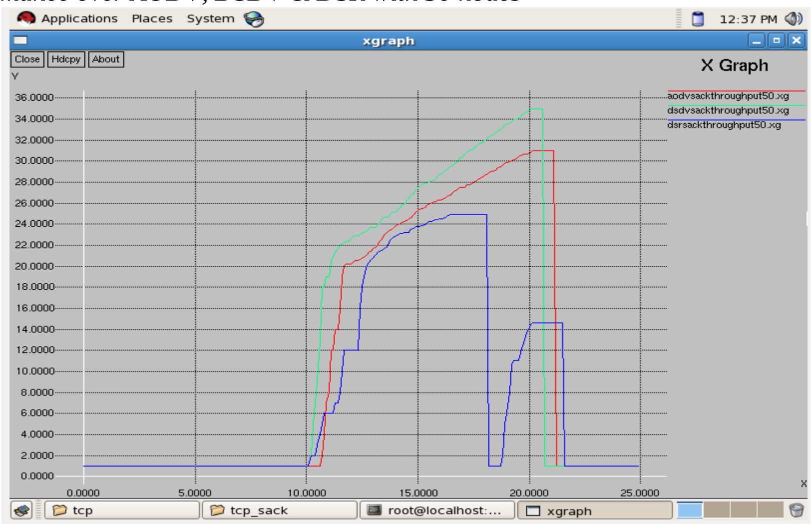

Figure 3: X-Graph representing throughput for TCP-SACK Simulation with 50 nodes in AODV, DSDV & DSR.

In fig.3, Here throughput performance of DSDV with TCP-SACK is better as compare to AODV and DSR.

4) TCP-VEGAS performance over AODV, DSDV & DSR with 50 nodes

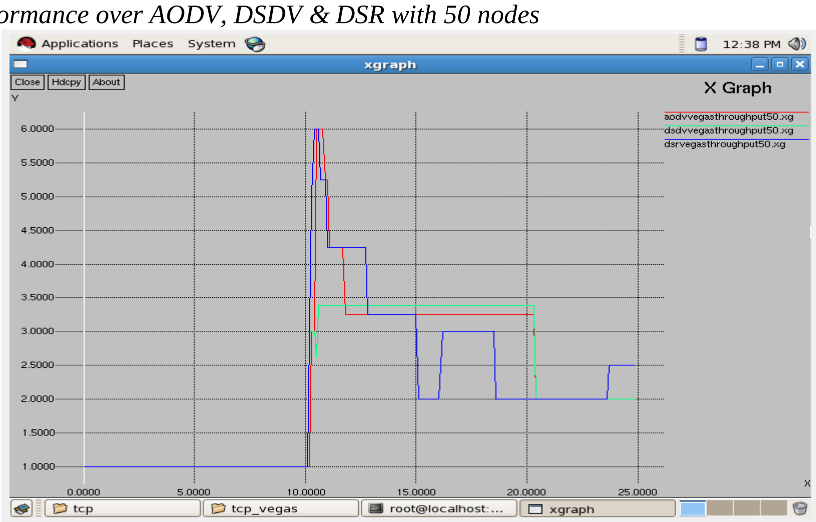

Figure 4: X-Graph representing throughput for TCP-VEGAS Simulation with 50 nodes in AODV, DSDV & DSR.

In fig.4,Here throughput performance of AODV and DSR with TCP-VEGAS is almost identical but better than DSDV.

5) TCP-WESTWOOD performance over AODV, DSDV & DSR with 50 nodes

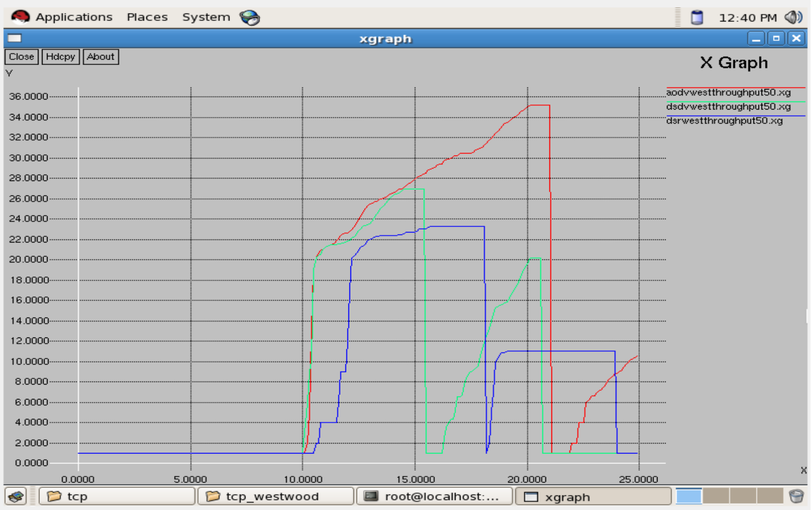

Figure 5: X-Graph representing throughput for TCP-WESTWOOD Simulation with 50 nodes in AODV, DSDV & DSR.

In fig 5,Here throughput performance of AODV is much better in case of TCP-WESTWOOD than DSDV and DSR.

V. CONCLUSION

In this work we perform a simulation analysis of different routing protocols on different TCP variants over Mobile Adhoc Networks. we presented the simulation of AODV, DSDV and DSR with TCP, TCP New reno, TCP Vegas, TCP Sack and TCP Westwood in MANET. It also shows the X-graphs of Throughput in simulation. The implementation is performed in NS2 and analysis is presented using X-graphs. Different Routing Protocol perform well over different TCP Variants.According to the results which are obtained in the simulation result and discussion section by considering the throughput and graph generation.The Throughput performance of AODV is much better in case of TCP-Westwood,TCP Vegas and with TCP New-reno and Throughput performance of DSDV is much better in case of TCP-Sack and with TCP.And the througput Performance of DSR and AODV is identical with TCP Vegas.

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