Performance Evaluation of TCP New Reno and TCP Westwood Over AODV in Mobile Ad-Hoc Network

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Abstract—*MANET is an infrastructure less network with no fixed Base Station for communication. Intermediate mobile nodes act as router to deliver the packets between two nodes. So, MANET is a highly dynamic network. But the wireless network suffers from significant throughput degradation due to mobility. It uses Congestion Control and Avoidance algorithms which have been proposed for TCP/IP protocols, namely: TCP New-Reno and TCP Westwood. In this paper we have evaluated the performance of TCP algorithms over AODV for throughput. The effect of throughput on the TCP variants with different node scenarios was studied.*

Keywords: -TCP New Reno, TCP Westwood, Throughput, AODV.

I. INTRODUCTION

Wireless cellular systems are in use since 1980s. Their evolutions have been seen to first, second and third generation's wireless systems. The latest elevation such as Bluetooth introduced a new class of wireless systems popularly known as mobile ad-hoc networks. Mobile ad-hoc networks also called "short live" networks work as infrastructure-less network. It can be easy to deploy in any situation where it is not possible otherwise. Mobile ad-hoc network is a self-governing system of mobile nodes that are connected through wireless links where each mobile node work as an end host and a router for all other mobile nodes in the network.

An ADHOC network is a collection of mobile nodes and wireless communication network is used to connect these mobile nodes. This network is known as MOBILE ADHOC NETWORK (MANET). Each device in a MANET moves independently. MANET is an infrastructure less network with no fixed Base Station for communication. Intermediate mobile nodes act as router to deliver the packets between two nodes. So, MANET is a highly dynamic network.

A. MANET architecture

The simplified architecture of MANET is shownin the figure where the research activities will be band together according to a layered approach into three main areas:

- Enabling technologies
- Networking
- Middleware and applications.

B. Ad Hoc on -Demand Distance Vector Routing (AODV)

It is an On-Demand routing Protocol. Each Node maintains only the next hop information of the route to destination. Destination sequence number is used to check the freshness of the route to destination. Periodic use of Beacons i.e. Hello packets used to check the presence of the neighbor. Each node uses a sequence number which is increased whenever the node observe a change in neighbor topology. Each node maintains a routing table.

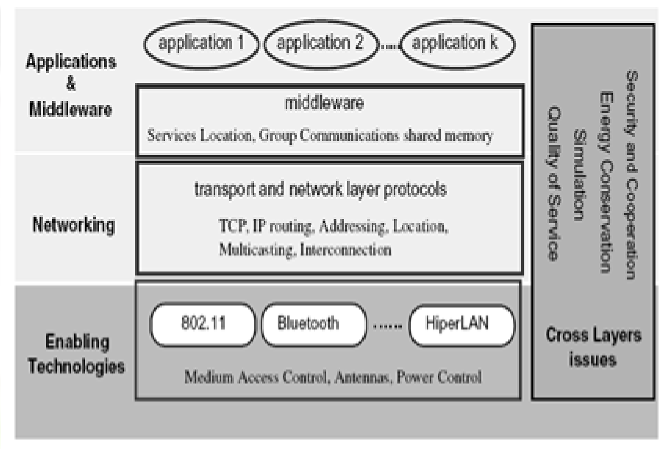

Fig. 1: MANET Architecture

C. TCP in MANET

TCP (Transmission Control Protocol) was designed to provide reliable end to end delivery of data over unreliable network. Most of the TCP deployments have been carefully designed in the context of wired networks. Ignoring the properties of wireless ad hoc networks can lead to the implementations with poor performance. In order to adapt TCP to wireless network, improvements have been proposed in the literature to help TCP to differentiate between the different types of losses. Indeed, in mobile ad hoc networks losses are not always due to network congestion, as it is in the wired networks. In this paper, we have done a performance evaluation of different TCP variants over AODV.

II. TCP CONGESTION CONTROL ALGORITHM

The four phases are: Slow Start, Congestion Avoidance, Fast Retransmit and Fast Recovery which are described as follows:

A. Slow Start

Slow Start is a mechanism that is used by the sender to control the transmission rate, and is also known as sender based flow control. The rate of acknowledgements returned by the receiver helps to determine the rate at which the sender can transmit data. When a TCP connection established, the Slow Start algorithm sets the size of congestion window to one segment, which is the maximum segment size (MSS) initialized by the receiver during the connection establishment phase. As the acknowledgements are returned by the receiver, the size of congestion window increases by one segment for each acknowledgement returned. At some point the congestion window may become too large that reaches to the ssthresh, a point during Slow Start that the network is forced to drop one or more packets due to overload or congestion. At this point, Congestion

Avoidance is used to slow the transmission rate and also Slow Start is used in conjunction with Congestion Avoidance as the means to get the data transfer going again so it doesn't slow down and stay slow.

B. Congestion Avoidance

In the Congestion Avoidance phase, timer expiring or the reception of three duplicate ACKs can implicitly signal the sender that the network is congested. The sender immediately sets its window to one half of the current window size. If congestion was indicated by a timeout, the congestion window is reset to one segment, which automatically puts the sender into Slow Start phase.

C. Fast Retransmit and Fast Recovery

TCP sets a timer each time whenever a data segment is transmitted, and thus it ensures the reliability. TCP retransmits the packet when it does not obtain any acknowledgement within the fixed time-out interval. The sender implements the fast retransmit algorithm for identifying and also repairing the loss. This fast retransmit phase is used based on the incoming duplicate ACKs if there are at least three duplicate ACK's it can be assumed that a data segment has been lost. In that case, the sender will retransmit the missing data packets without waiting for a retransmission timer to expire.

After the missing data segment is retransmitted, the TCP will initiate the fast recovery mechanism until a non-duplicate ACK arrives. The fast recovery algorithm is an improvement of congestion control mechanism that ensures higher throughput even during moderate congestion and the receiver yields the duplicate ACK only when another segment is reached to it. Thus in fast recovery algorithm, congestion avoidance phase is again invoked instead of slow start phase as soon as the fast retransmission mechanism is completed.

III. TCP VARIANTS

A. TCP New Reno

TCP New Reno is a slight modification over TCP-Reno. It is able to detect multiple packet losses and thus it is much better than Reno in the event of multiple packet losses. Like Reno, New-Reno also enters into fast-retransmit phase 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. Thus it overcomes the problem faced by Reno of reducing the congestion window multiples times. 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.
- 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.

B. TCP Westwood

Westwood TCP is a new congestion control algorithm that is based on end-to-end bandwidth estimate. In particular, TCP Westwood estimates the available bandwidth by counting and filtering the flow of returning ACKs and adaptively sets the *cwnd* and the *ssthresh* after congestion by taking into account the estimated bandwidth.

In particular, when three DUPACKs are received, both the congestion window (*cwnd*) and the slow start threshold (*ssthresh*) are set equal to the estimated bandwidth (*BWE*) times the minimum measured round trip time (*RTTmin*); when a coarse timeout expires the *ssthresh* is set as before while the *cwnd* is set equal to one.

The pseudo code of the Westwood algorithm is reported below:

a) On ACK reception:
cwnd is increased accordingly to the Reno algorithm;
the end-to-end bandwidth estimate *BWE* is computed;
b) When 3 DUPACKs are received:
ssthresh =max(2, (*BWE** *RTTmin*) / *seg_size*);
cwnd = *ssthresh*;
c) When coarse timeout expires:
ssthresh = max(2,(*BWE** *RTTmin*) / *seg_size*);
cwnd = 1;

IV. SIMULATION ANALYSIS

In this paper we presented a simulated comparison between two of the better TCP variants in ad hoc networks, TCP New Reno and TCP Westwood. We implemented these TCP variants on a reactive routing protocol, AODV (Ad hoc On-demand Distance Vector) in Mobile Ad hoc Networks. We presented snapshots of simulations of 25 nodes, 50 nodes, 75 nodes and 100 nodes networks with respective X-graphs representing throughput of TCP New Reno and TCP Westwood.

A. Simulation of AODV with 25 nodes

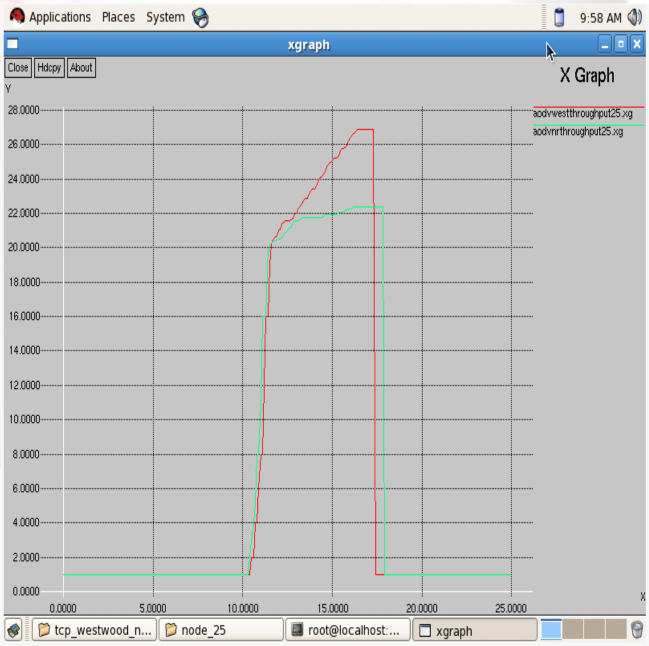

Fig. 2: X-graph of throughput of Westwood and New Reno with 25 nodes

B. Simulation of AODV with 50 nodes

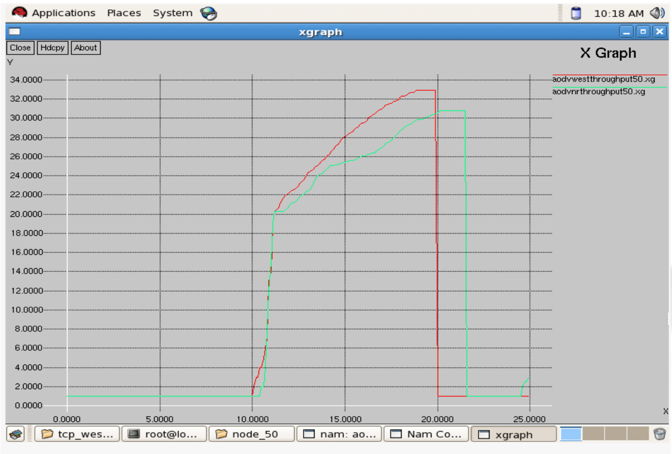

Fig. 3: X-graph of throughput of Westwood and New Reno with 50 nodes

C. Simulation of AODV with 75 nodes

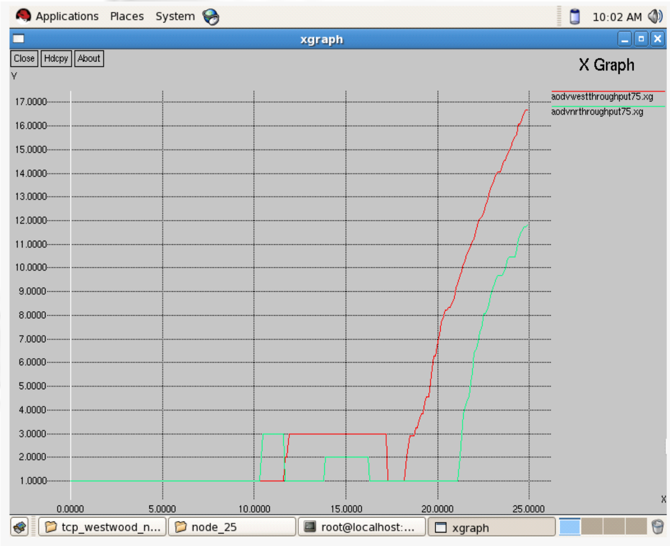

Fig. 4: X-graph of throughput of Westwood and New Reno with 75 nodes

D. Simulation of AODV with nodes100

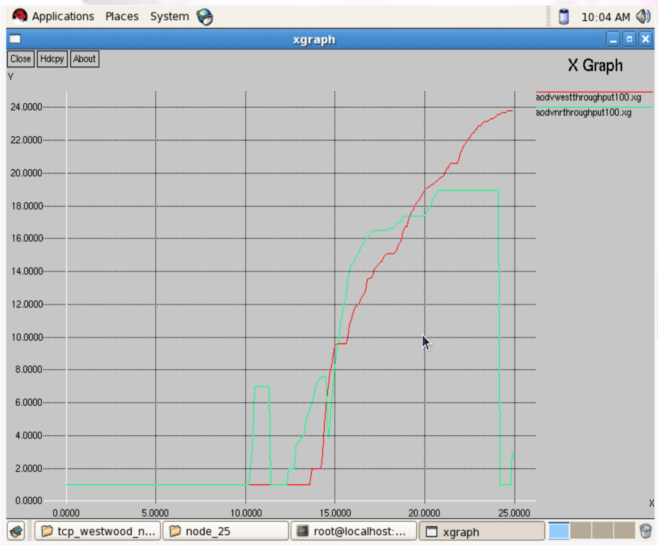

Fig. 5: X-graph of throughput of Westwood and New Reno with 100 nodes

V. Conclusion

The Proposed work is about the Comparison of different TCP's over AODV. In the proposed work approach, we presented the simulation of TCP New Reno, Westwood over AODV in MANET. The Simulation shows the data transfer between these nodes with 25 nodes, 50 nodes 75 nodes and 100 nodes. It also shows the X-graphs of throughput comparisons between TCP New Reno and TCP Westwood in simulation with 25 nodes, 50 nodes, 75 nodes and 100 nodes. The implementation is performed in NS2 and analysis is presented using X-graphs. It is found that TCP New Reno performs much better in comparison with TCP Westwood.

VI. Future Scope

The Proposed system can be enhanced in future by other researchers by working over other different TCP's with other different protocols. Such a TCP variant can be developed which will perform best in any case over different routing protocols in MANETs.

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