Comparative Analysis of Routing Protocols
And TCP in MANETS

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Abstract—Ad hoc networks are characterized by a lack of infrastructure, and by a random and quickly changing network topology; thus the need for a robust dynamic routing protocol that can accommodate such an environment. The paper brings out a comparison among various routing protocols in different scenarios with TCP variants, for their better understanding and implementation. A comprehensive performance evaluation of various routing protocols and the TCP is presented to understand the nature of the TCP performance in different scenarios with variable number of nodes. Three different routing protocols (AODV, TORA and OLSR) have been evaluated with four different TCP variants (Tahoe, Reno, New Reno and SACK) in two different scenarios having 5 and 12 nodes. The performance parameters on the basis of which routing protocols are graded are throughput, delay and congestion window. Conclusions are drawn based on the simulation results and the comparison results are graphically depicted and explained.

Keywords: MANET, Wireless networks, routing, AODV, Throughput, OPNET

1. INTRODUCTION

TCP is designed for wired network, but with the technology emerging towards wireless medium, the need to implement TCP in ad hoc networks is of great importance but it faces many problems. TCP has poor performance in MANET due to dynamic topology, shared medium, high error ratio; channel connotation and multi hop architecture [1]. In order for the ad hoc networks to operate as efficiently as possible, appropriate on-demand routing protocols have to be incorporated, to find efficient routes from a source to a destination, taking node mobility into consideration. The Mobility influences ongoing transmissions, since a mobile node that receives and forwards packets may move out of range. As a result, links fail over time. In such cases a new route must be established. Thus, a quick route recovery procedure should be one of the main characteristics of a routing protocol [3]. In an ad hoc network, mobile nodes communicate with each other using multi-hop wireless links. There is no stationary infrastructure such as base stations in ad hoc networks. Each node in the network also acts as a router; forwarding data packets for other nodes, which in such a network move arbitrarily, thus network topology changes frequently and unpredictably. Such problems are associated with the MANET performance and therefore evaluation and optimization techniques are necessary to opt and adhere for the better execution of the transmission medium. To measure the performance of different TCP variants, simulation study has been conducted in practice. MANET utilizes TCP and UDP for data transmission and our study focuses on different variants of the TCP i.e. particularly Tahoe, Reno, New Reno and SACK explicitly using AODV, TORA and OLSR protocols.

2. PROTOCOLS

In this section, we give a brief overview of the routing protocols used in our performance analysis. We also discuss the variations of the TCP protocol that were considered.

A. ROUTING PROTOCOLS

AODV and TORA are on-demand algorithms. Unlike proactive protocols such as OLSR, on-demand protocols do not maintain routes between all the nodes in an ad hoc network [5]. Rather, routes are established when needed through a route discovery process in which a route request is broadcast. A route reply is returned either by the destination or by an intermediate node with an available route. Route error messages are used to invalidate routing table entries when link failures are detected. The Ad Hoc On-Demand Distance Vector routing protocol (AODV) is an improvement of the Destination-Sequenced Distance Vector routing protocol (DSDV). It is based on distance vector and also uses the destination sequence numbers to determine the freshness of the routes. AODV requires hosts to maintain only active routes. The advantage of AODV is that it tries to minimize the number of required broadcasts. It creates the routes on an on-demand basis, as opposed to maintain a complete list of routes for each destination. Therefore, the literature on AODV, classifies it as a pure on-demand route acquisition system.
TORA is a reactive routing algorithm based on the concept of link reversal and used in MANETs to improve the scalability. Highly dynamic mobile ad hoc networks can be used by TORA. It is an adaptive routing protocol used in multi-hop networks. It makes scaled routes between source and destination.

There are three basic functions in TORA:

- Route Creation
- Route Maintenance
- Route Erasure

OLSR is a proactive link-state routing protocol, which uses Hello and Topology Control (TC) messages to discover and then disseminate link state information throughout the mobile ad-hoc network. Individual nodes use this topology information to compute next hop destinations for all nodes in the network using shortest hop forwarding paths.

B. TRANSPORT PROTOCOLS

After the introduction of first version of TCP, several variants are introduced, here we are discussing the most famous implementation of TCP called Tahoe, Reno, New Reno and SACK.

TAHOE

In the first version of TCP there was no congestion control mechanism. So after observing the congestion, Jacobson introduced several Congestion Control algorithms and this version is called TCP-Tahoe. The congestion control algorithms introduced in this version are:

a) Slow Start
b) Congestion Avoidance
c) Fast Retransmit

RENO

TCP Reno is the most widely adopted Internet TCP protocol. It employs four transmission phases:

a) Slow Start
b) Congestion Avoidance
c) Fast Retransmit
d) Fast Recovery.

NEW RENO

TCP New Reno is a modification of TCP Reno. It improves retransmission process during the fast recovery phase of TCP Reno. TCP New Reno can detect multiple packet losses and does not exit the fast recovery phase until all unacknowledged segments at the time of fast recovery are acknowledged. Thus, as in TCP Reno, it overcomes reducing the congestion window size multiple times in case of multiple packet losses. The remaining three phases (slow start, congestion avoidance, and fast retransmit) are similar to TCP Reno.

SACK

SACK algorithm allows a TCP receiver to acknowledge out-of-order segments selectively rather than cumulatively by acknowledging the last correctly in order received segment. The receiver acknowledges packets received out of order and the sender then retransmits only the missing data segments instead of sending all unacknowledged segments.

3. SIMULATION SETUP

The general evaluation of the various TCP agents in the following section is conducted with the OPNET 11.5 tool. The simulation is conducted in two different scenarios with varying number of nodes. The simulation area chosen is 1000mx1000 m
where nodes are placed randomly. The mobility model used is the Random Waypoint. In the first scenario, the network we simulated consisted of 5 nodes randomly placed on a 1000m x 1000m field and 12 nodes in the second scenario. We utilized a mobility pattern based on the random waypoint model. Speed of mobile nodes is constant at 10m/s, and only zero-length pause times are considered.

In both the scenarios, all the three routing protocols are evaluated based on the three performances metric which are Throughput, Delay and the Congestion Window. The simulation environment for these scenarios is:

- Various numbers of nodes which are 5 & 12 nodes
- File size is set to 10 Mbytes
- Area size is set to 1000m x 1000m
- Node Speed is fixed to 10 m/s
- Random Way Point mobility model is used
- Network Protocol is IPv4

Network traffic is created by using FTP application between the server and the mobile nodes. The simulation duration is 150 seconds. Experiments are run for different protocols.

**A. Five Nodes Scenario:**

For five nodes scenario, the details of different protocols are as shown in Table 1. There are five nodes working as clients to establish connection with a fixed node working as source, and to transfer a file of the same size over each connection.

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<th>THROUGHPUT/ DELAY/ CONGESTION WINDOW</th>
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**4. SIMULATION RESULTS**

**A. Throughput**

From figure 1, by looking at the throughput performance between AODV and TORA at approximately 60 seconds, we can say AODV has better throughput performance over TORA (except for Tahoe). Comparing AODV with OLSR at the approximation of 60 sec, AODV provides better throughput performance, in all the graphs. Total time consumed by each protocol to send the data through SACK, New Reno, Reno and Tahoe is relatively smaller for AODV followed by OLSR and than TORA. It means that TORA has worst throughput performance in each of the 4 cases for MANET 5 nodes [9]. The reason behind TORA having less performance is that TORA works for route recreation, maintenance and erasure, if dropping of the route occurs, it requires more time and has bad impact in the data performance.
Figure 1: Throughput comparisons in 5 nodes scenario
12 Nodes Scenario

From figure 2, we observe that graph behavior remains almost same as for 5 Nodes Scenario.
Figure 2: Throughput comparisons in 12 nodes scenario

B. Delay

Figure 3 holds the simulation results for each and every TCP variant with respect to different routing protocols all together. With 5 node scenario, TORA has the highest delay as compared to OLSR and AODV which validate our simulation results. With 12 nodes scenario, TORA and OLSR have approximately same delay, which is not considered as a good perception in wireless networks, as we encounter numerous losses and delays due to SNR, reflection, diffraction and inter symbol interference, so the delay measure is considered highly sensitive.
C. Congestion window

Figure 4 holds graphs defined earlier for the 5 node simulated scenario; there is much of dissimilarity within each set of variants and routing protocols. Congestion window of AODV reaches to the maximum of 7,000 bytes and remains there which depicts least of delay and better performance.

TORA shows different results in all cases with CW size varying from around 2000 to 5500 bytes. So it’s likely to know that TORA congestion window is quite uncertain and its use in the MANET network will have severe results.
5. CONCLUSIONS
We adhere to the simulation results as evidence that TCP variants have minor affect on the overall results except in few cases, but the major dependence lies on MANET routing protocols. Simulation observation based on AODV, OLSR and TORA clearly describes about the performance evaluation by measuring throughput, delay and congestion window indicating that the best routing protocol for MANET is AODV.

Presently numerous MANET routing protocols of interest have been selected by simulation in OPNET tool. Another possibility can be of doing the same work through another tool like NS-2 and check if we get better or different results. Also, selection of other routing protocols can be used for the performance evaluation or other parameters of performance could be considered for simulation such as single packet loss and multiple packet losses.

REFERENCES


