Effective Analysis of Different Parameters in Ad hoc Network for Different Protocols

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Abstract— A wireless Ad-hoc network consists of wireless nodes communicating without the need for a centralized administration, in which all nodes potentially contribute to the routing process. A user can move anytime in an ad hoc scenario and, as a result, such a network needs to have routing protocols which can adopt dynamically changing topology. To accomplish this, a number of ad hoc routing protocols have been proposed and implemented, which include Dynamic Source Routing (DSR), ad hoc on-demand distance vector (AODV) routing, and temporally ordered routing algorithm (TORA).

In this paper, we analyze the performance differentials to compare the above-mentioned commonly used ad hoc network routing protocols. We report the simulation results of four different scenarios for wireless ad hoc networks having thirty nodes. The performances of proposed networks are evaluated in terms of number of hops per route, retransmission attempts, traffic sent, traffic received and throughput with the help of OPNET simulator. Channel speed 11Mbps and simulation time 20 minutes were taken. For this above simulation environment, TORA shows better performance over the two on-demand protocols, that is, DSR and AODV.

Keywords— AODV, DSR, TORA, OPNET, MANET, DSSS

I. INTRODUCTION

A wireless Ad-hoc network consists of wireless nodes communicating without the need for a centralized administration. A collection of autonomous nodes or terminals that communicate with each other by forming a multihop radio network and maintaining connectivity in a decentralized manner is called an ad hoc network. There is no static infrastructure for the network, such as a server or a base station. The idea of such networking is to support robust and efficient operation in mobile wireless networks by incorporating routing functionality into mobile nodes. Fig. 1 shows an example of an ad hoc network, where there are numerous combinations of transmission areas for different nodes. From the source node to the destination node, there can be different paths of connection at a given point of time. But each node usually has a limited area of transmission as shown in Fig. 1 by the oval circle around each node. A source can only transmit data to node B but B can transmit data either to C or D. It is a challenging task to choose a really good route to establish the connection between a source and a destination so that they can roam around and transmit robust communication. There are four major ad hoc routing protocols AODV, DSDV, DSR, TORA. All these protocols are constantly being improved by IETF [1]. As a result, a comprehensive performance evaluation is of ad hoc routing protocols essential. In this work, OPNET simulator version is used to simulate three ad hoc routing protocols, that is, DSDV, AODV, and TORA. We evaluated all available metrics and then performed a comparative performance evaluation. Since these protocols have different characteristics, the comparison of all performance differentials is not always possible. The following system parameters are taken for the simulation of all the above scenario at channel speed 11Mbps and simulation time 20 minutes. The comparative studies of the simulation results for these parameters are also reported.

(i) Number of hops per route,
(ii) Traffic received and sent,
(iii) Total route requests sent,
(iv) Total route replies sent,
(v) Control traffic received and sent,
(vi) Data traffic received and sent,
(vii) Retransmission attempts,
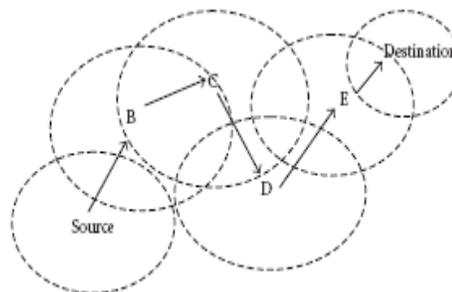(viii) Throughput,

Figure 1 Ad hoc networking model.

To the best of our knowledge, very few papers have been published. In section 2, we review the mostly used wireless ad hoc protocols. In Section 3, we present the performance metrics of our simulation. Section 4 performance comparison of the protocols. We draw our conclusions in Section 5.

II. AD HOC ROUTING PROTOCOLS

Among the various ad hoc routing protocols proposed in the literature [1, 2], TORA, DSR, and AODV appear to be the most promising. TORA [3, 4] is a distributed routing protocol for ad hoc networks, TORA is designed to minimize reaction to topological changes. A key concept in its design is that control messages are typically localized to a very small set of nodes. It guarantees that all routes are loop-free (temporary loops may form), and typically provides multiple routes or any source/destination pair. It provides only the routing mechanism and depends on Internet MANET Encapsulation Protocol (IMEP) [5, 6] for other underlying functions. This uses a link reversal algorithm.. TORA involves four major functions: creating, maintaining, erasing, and optimizing routes [7–9].

The DSR protocol [1, 10, 11] also belongs to the class of reactive protocols and allows nodes to dynamically discover a route across multiple network hops to any destination. Source routing means that each packet in its header carries the complete ordered list of nodes through which the packet must pass. DSR uses no periodic routing messages (e.g. no router advertisement), thereby reducing network bandwidth overhead, conserving battery power and avoiding large routing updates throughout the ad hoc network. Instead DSR relies on support from the MAC layer (the MAC layer should inform the routing protocol about link failures). The two basic modes of operation in DSR are route discovery and route maintenance [9].

The AODV algorithm [12] is based upon the distance vector algorithm (i.e. AODV only requests a route when neded and does not require nodes to maintain routes to destinations that are not actively used in communications). It shares on-demand characteristics of DSR, and adds the hop-by-hop routing, sequence numbers, and periodic beacons from DSDV[13]. It has the ability to quickly adapt to dynamic link conditions with low processing and memory overhead. AODV offers low network utilization and uses destination sequence number to ensure loop freedom. It is a reactive protocol implying that it requests a route when needed and it does not maintain routes for those nodes that do not actively participate in a communication. An important feature of AODV is that it uses a destination sequence number, which corresponds to a destination node that was requested by a routing sender node. The destination itself provides the number along with the route it has to take to reach from the request sender node up to the destination. If there are multiple routes from a request sender to a destination, the sender takes the route with a higher sequence number. This ensures that the ad hoc network protocol remains loop-free. AODV keeps the following information with each route table entry [12]:

(i) destination IP address ,

(ii) destination sequence number,

(v) hop count, that is, number of hops required to reach the destination,

(vi) next hop (i.e. the neighbor, which has been designated to forward packets to the destination for this route entry)

(vii) request buffer,

(viii) lifetime, (i.e. the time for which the route is considered valid)

III. PERFORMANCE METRICS

We evaluated key performance metrics for three different applications using DSR, TORA, and AODV protocols. The parameters used for wireless LAN application performance evaluation include: control traffic received and sent, data traffic received and sent, throughput, and retransmission attempts.

We used the following parameters for evaluating the effect of variation on different protocols: routing traffic received and sent, total traffic received and sent, number of hops, route discovery time, and ULP traffic received and sent, throughput.
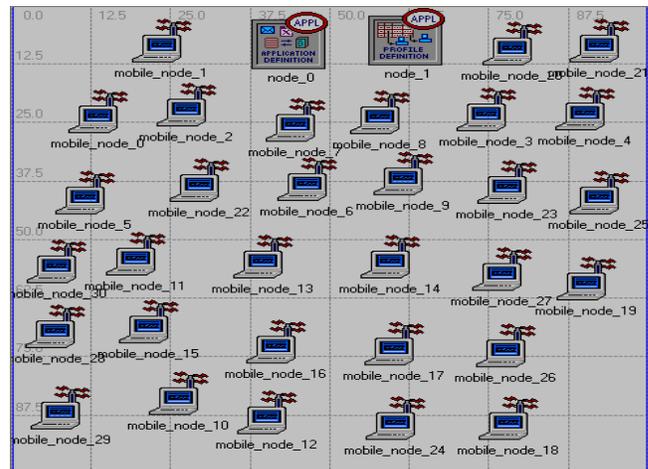

Figure 2 A proposed model of the ad hoc network.

IV. PERFORMANCE COMPARSION OF THE PROTOCOLS

For all simulations, the same movement models were used, and the number of traffic sources was fixed at 30. Figure 2 shows a model of nodes used to simulate different ad hoc network protocols. A square of 20 meters is used to define the area of node's mobility. In the simulation, the following parameters are used:

(i) duration: 20 minutes,

(ii) speed: 256, 512, 1024

(iii) nodes: 30,

A. Wireless LAN

Fig. 3 shows the control traffic received in packets/s for DSR, TORA, and AODV protocols for a wireless LAN

application. Figure 2 shows that the TORA protocol performs better than the other two. Although AODV does not perform well at the beginning, later it does well. DSR's performance remains average during the entire evaluation time. Figure 4 shows the control traffic sent in packets/sec. It is obvious that TORA performs better than AODV and DSR. Although DSR and AODV have shown an average performance throughout the entire simulation, they show better performance compared to TORA at the end. TORA uses a fast router-finder algorithm, which is critical for TORA's better performance. Both DSR and AODV have to go through route creation using RREQ and RREP messages. Once the routes are created, DSR and AODV tend to do better than TORA. As a result, we observe from Figures 3 and 4 that, near the end of simulation time, both AODV and DSR show better performance than TORA.
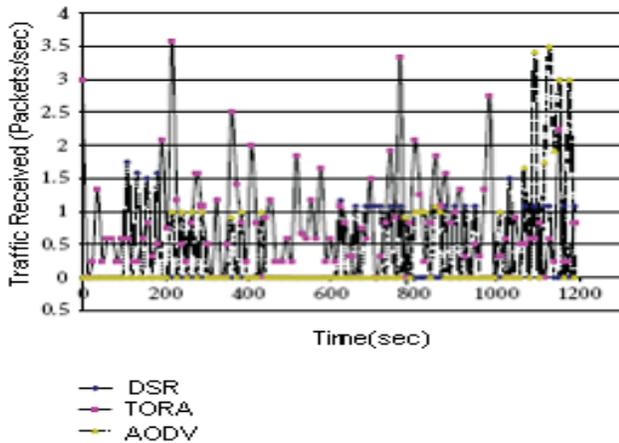

Figure 3 Control traffic received for different protocols in wireless LAN.
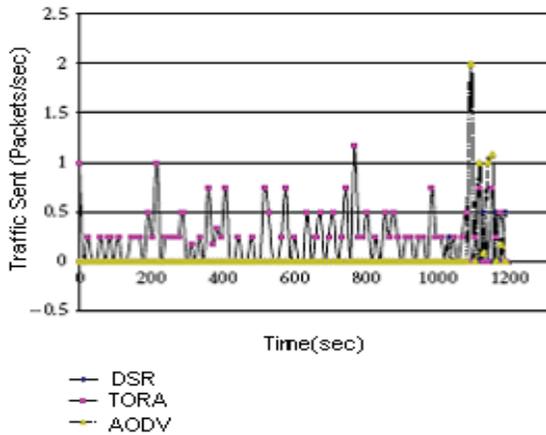

Figure 4 Control traffic sent for different protocols in wireless LAN.

Figs. 5 and 6 shows the data traffic received and data traffic sent in packets/sec, respectively, for DSR, AODV, and TORA protocols. From fig. 5, it is evident that, at the beginning of the simulation TORA appears to dominate over AODV and DSR, but at the end, AODV yields the best result. DSR shows poor performance and the traffic remains always at the lower level, whereas AODV performs well

most of the time. In Figure 6, we observe that TORA performs well during most of the simulation time. AODV shows consistent performance and peaks at the end of the simulation. DSR does not show any positive traffic except for the last few seconds of the simulation. Figure 7 shows the throughput in bits/sec for DSR, TORA, and AODV protocols, where AODV shows significantly better performance than the other two, and TORA performs slightly better than DSR. Figure 8 shows the retransmission attempts in packets/sec as a function of time for wireless LAN involving different protocols. It is evident from Figure 8 that TORA requires a lot of retransmission attempts before it can successfully transmit data due to the fact that only TORA uses UPD packet. When a node first gets a QRY message for a destination, if it does not have a route for the requested destination, it broadcasts a UPD message and increases the height of the node. In this way, it tries to transmit the UPD message until it gets the destination node. DSR and AODV have almost the same logic to find a route and show almost similar performance near the end of the simulation time.
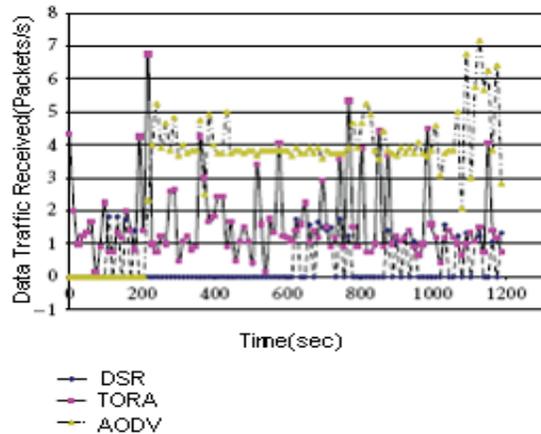

Figure 5 Data traffic received for different protocols in wireless LAN.

V. CONCLUSION

In this paper, OPNET Simulator has been used, we evaluated the performance of widely used ad hoc network routing protocols. The simulation characteristics used in this research, that is, the control traffic received and sent, data traffic received, throughput, retransmission attempts, and traffic received, are unique in nature, and are very important for performance evaluation of any networking protocol.

Performance evaluation results for some ad hoc network protocols were previously reported [1, 14], whichprimarily covered the impact of the fraction of packets delivered, end-to-end delay, routing load, successful packet delivery, and control packets overhead. In this paper, we perform a thorough analysis that

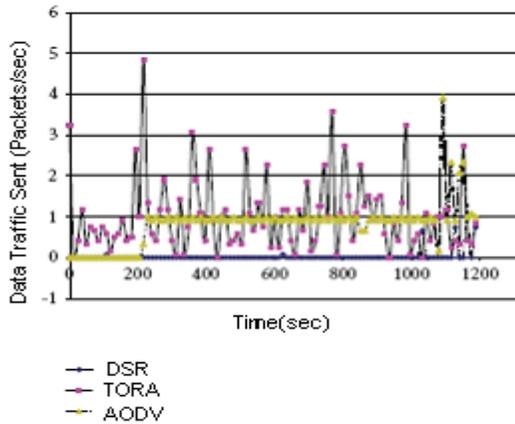includes additional parameters. For comparative performance

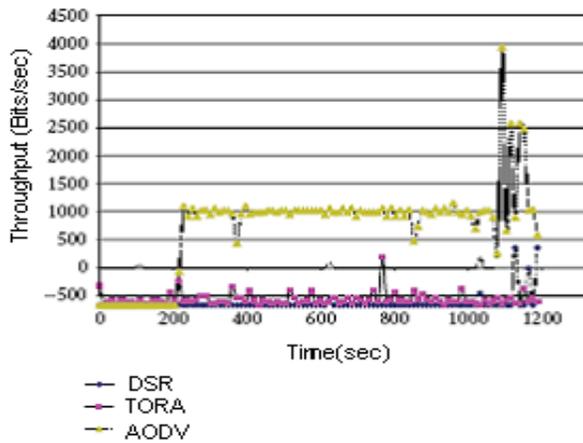Figure 6 Data traffic sent for different protocols in wireless LAN.

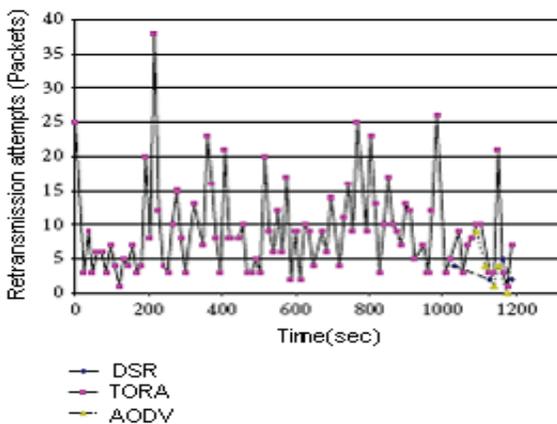Figure 7 Throughput of different protocols in wireless LAN.

Figure 8 Retransmission attempts for different protocols in wireless LAN.

analysis, we first simulated each protocol for ad hoc networks with 30 nodes. In case of wireless LAN, TORA shows good performance for the control traffic received, control traffic sent, and data traffic sent. However, AODV shows better performance for data traffic received and throughput. DSR and AODV show poor performance as compared to TORA for the control traffic sent and throughput. However, TORA and AODV show an average level of performance for the data traffic received and data traffic sent, respectively.

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