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Analysis and Delay Function of Ad hoc Routing Network Protocols

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Abstract: A mobile ad hoc network is a collection of wireless mobile nodes communicating with each other using multi-hop wireless links without any existing network infrastructure or centralized administration. In recent years, a variety of routing protocols targeted specifically at this environment have been developed and some performance simulations are made. However, the related works took the simulation model with a constant network size and a varying pause times or mobility velocities. Based on the QoS (delay, throughput), routing load and the connectivity, this paper systematically discuses the performance evaluation and comparison of four typical routing protocols of ad hoc networks with the different simulation model and metrics, and drew more complete and valuable conclusions.

***Keywords*:** Ad hoc Network, Delay, AODV, TORA, Throughput, Protocols, DSR.

I. INTRODUCTION

Goal of this paper is to carry out a systematic performance study for four typical routing protocols of ad hoc networks, which include one distance vector routing protocol DSDV [1] and three on-demand routing protocols AODV [2], DSR [3] and TORA [4]. DSDV is a table-driven protocol based on the classical Bellman–Ford mechanism. The improvements made to Bellman–Ford algorithm include freedom from loops in the routing table. Every mobile node in the network maintains a routing table in which all of the possible destinations within the network and the number of hops to each destination are recorded.

While AODV, DSR and TORA share the on-demand behaviour in that they initiate routing activity only in the presence of data packets in need of a route, many of their routing mechanism are different. AODV uses a table-driven routing framework and destination sequence numbers, DSR uses a source routing, whereas TORA uses a link reversal routing mechanism. Commonly, the latter three have a less routing load and the former has a less end-to-end delay.

Biao et al. [5], Josh Broch, David A. Maltz, David B. Johnson, Yih-Chun Hu and Jorjeta Jetcheva [6] investigate the routing protocols of AODV, DSDV, DSR and TORA. The former simulation modelled a network of 60 mobile hosts and varying pause times, the latter modelled sceneries with 50 nodes and pause time of 0, 30, 60, 120, 300, 600 and 900 s, respectively. Das et al. [7] carried out the simulation analysis to AODV and DSR. Their simulation has a model of 50 (the first group of experiment) and 100 (the second group of experiment) nodes at varying pause times. The above mentioned works consider the simulation model with a constant network size and a varying pause times or mobility speeds. These works do not take into account the influence on the protocols when the mobile node's pause time is invariable but the network size is changing. On the contrary, this paper considers the simulation model with a dynamic network size and an invariable pause time which should be zero under weakest case. So we investigate performances of the routing protocols from different categories under various network scenarios (e.g., different network size, mobility speeds, etc.). This paper systematically discuses the performance evaluation and comparison of four typical routing protocols, AODV, DSDV, DSR and TORA, in ad hoc networks, which take the QoS (delay, throughput), routing load and connectivity as evaluation metrics.

Table 1: Delay and Throughput Analysis on Different Ad Hoc Networking Protocols

Metrics	**Protocols**			
	AODV	**DSR**	**TORA**	**DSDV**
Delay	2	4	3	1
Throughput	1	3	4	2

II. DELAY AND THROUGHPUT ANALYSIS

Note: NO* denotes TORA itself does not support broadcasts, but LAM [8], which moves above the TORA, supports broadcasts.

III. AVERAGE DELAY ANALYSIS

The average packet delay increases for all routing protocols with numbers of nodes higher than 50, as shown in Fig. 1. DSR and TORA have a longer delay than DSDV and AODV.

When requesting a new route, DSR first searches the route cache storing routes information it has learned over the past routing discovery stage and has not used the timer threshold to restrict the stale information which may lead to a routing failure, moreover, DSR needs to put the routes information not only in the route reply message but also in the data packets which relatively make the data packets longer than before. Both of the two mechanisms make DSR to has a long delay than the rest three. TORA only stores the localization of control messages to a very small set of nodes near the occurrence of a topology change which on the one hand, makes TORA have a lower routing load on the other hand, due to having a vague memory of the distant place nodes; correspondingly, its delay is also longer (Table 1).

DSDV exhibits a shorter delay because it is a kind of table-driven routing protocol; each node maintains a routing table in which all of the possible destinations with the network and the number of hops to each destination are recorded, only packets belonging to valid routes at the ending instant get through. A lot of packets are lost until new (valid) route table entries have been propagated through the network by the route update messages in DSDV.

AODV uses the source-initiated in the route discovery process, but at the route maintenance stage, it uses the way of the table-driven, which also shows the better delay characteristic.

The literature [5] has drawn a conclusion that DSR has a lower delay than AODV with a longer pause time. When pause time is shorter, the conclusion is opposite. The literature [7] states DSR has a better delay than AODV with the sources 10 or 20, when the sources are bigger than 30, AODV shows a smaller delay. In our simulation experiments environment of high-speed movement and an increasing network size, DSR has always a longer delay than AODV. This is mainly in that the different simulation models are applied.

Table 2: Average Delay in Different Protocols

ADOV	DSDV	DSR	TORA
1.2	0.8	3.8	3.8
0.8	0.1	2.8	1.4
0.1	0.4	0.9	1.6
0.1	0.4	3.2	1.5
1.7	1.7	4.3	2

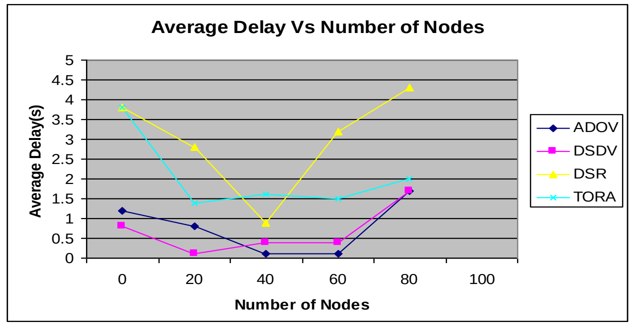

Figure 1: Average Delay versus Number of Nodes

IV. THROUGHPUT ANALYSIS

The average end to end throughput for the network is shown in Figs. 2 and 3, which reflects the usage degree of the network resources for the typical routing protocols. For the convenience to comparison, Fig. 2 only demonstrates the throughput-changing curve with the number smaller than 50, and Fig. 3 presents the complete simulation's throughput-changing curve.

With an offered load of 1 packets/s the maximum throughput is approximately 4500 kbps. Throughput increases quickly for AODV, DSR and DSDV with increased number of nodes. TORA on the other hand has difficulties in finding routes when number increases, which is clear from Fig. 3, where the throughput drops slightly with the number smaller than 50. Compared to AODV and DSR, the relatively lower throughput for DSDV is caused by packets that are sent (and lost) before routes have converged initially in the network. Note that all simulations are started without any established routes.

In detail, when the number of nodes is smaller than 30, DSR shows the better throughput characteristic, next are AODV and DSDV. With the network size bigger than 30 and smaller than 50, AODV has the best throughput, next are DSR and DSDV. AODV is still the highest with the number exceeding 50, but this time DSDV has a better throughput than DSR. Considering the results, we think that AODV has a high reliability in a high-speed and large-scale environment, and along with the increase number of nodes, DSDV also displays the better throughput characteristic. The reliability of TORA is worst. The literatures [5] and [7] merely drew the conclusion that the throughput of AODV is bigger than the DSR's, however, their works had not presented that the throughput of AODV is smaller than the DSR's with the size less than 30.

We find an interesting phenomenon that the routing load (with a larger number of nodes) is much higher for four protocols, more than the throughput [9] This is, however, expected, as n (positive integer number) times as many sources will produce about n times as much routing load in them, and whose increasing ratio is quicker than the throughput's.

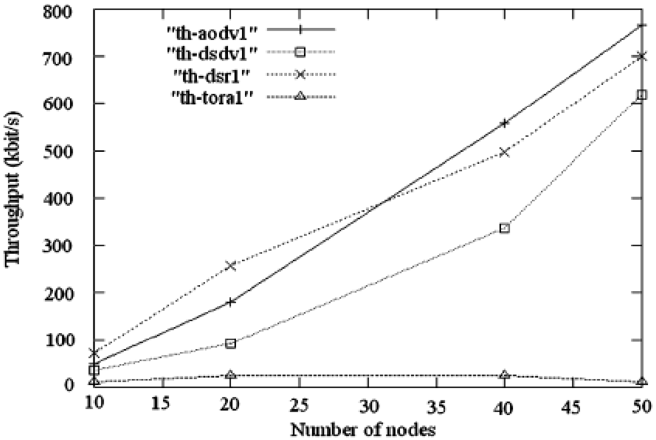

Figure 2: Throughput versus Number of Nodes (The Number of Nodes Is Smaller Than 50).

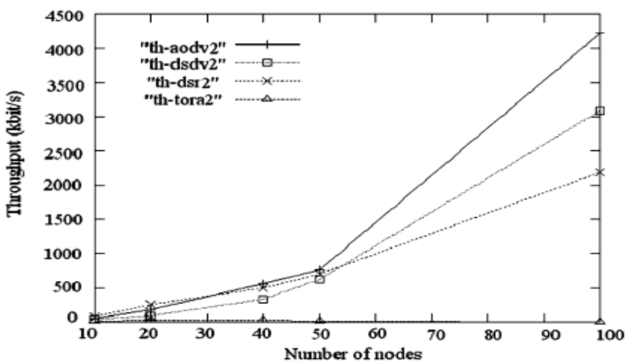

Figure 3: Throughput versus Number of Nodes.

V. PERFORMANCE SUMMARY

As mentioned above, we know that TORA has worst performance with long delay and large through put it functions as the underlying protocol for the routing algorithms and provides multicast capability. In these protocols DSR routing load is moderate, a large throughput and a long delay, which is suitable to the medium scale network environment without higher delay demand. Because DSDV must maintain the entire situation information, when topology changes frequently and network size increases, the increment of routing load is very quickly, and it is not fit for large-scale and high-speed moving wireless environment. In all the scenarios, AODV displays the smallest delay and the greatest throughput and the adaptive ability is also of relative strength.

Table 1 has given performance comparison of four kinds of routing protocols (network point more situations), and ‘‘1’’ denotes the best performance, ‘‘4’’ the worst.

VI. CONCLUSION

This paper discusses the simulation model for the variable network size and whose mutual connection in the network topology, it is appropriate to use the model to appraise the scalability and the ability to support QoS of the above four kinds of protocols for ad hoc network. The related works use the simulation model with a constant network size and a varying pause time. We use the different simulation model and more metrics and drew more complete and valuable conclusions. Our goal is not to highlight ourselves but to present a better understanding of the relative merits of these protocols and provide a beneficial reference for further study on ad hoc unicasts and multicast routing protocols for supporting the QoS.

VII. REFERENCES

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