Performance Evaluation and Model Using DSDV and DSR routing in Ad-hoc network

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Abstract:

A mobile ad hoc network (MANET) is a collection of wireless mobile nodes communicating with each other using multi-hop wireless links without any existing network infrastructure or centralized administration. Previously, a variety of routing protocols targeting specifically at this environment was developed and some performance simulations were made. However, the related works took the simulation model with a constant network size. On the contrary, this paper considers the problem from a different perspective, using the simulation model with dynamic network size. Furthermore, based on Quality Of Service QoS (delay, jitter) and routing load, this paper systematically discusses the performance evaluation and comparison of two typical routing protocols of ad hoc networks with different simulation model and metrics.

Keywords*:* Ad hoc networks, Performance evaluation, QoS, Routing protocols, Network simulation.

1. Introduction

In an Ad hoc network, mobile nodes communicate with each other using multi-hop wireless links. Such networks find applicability in disaster management environment, crowd control, military applications and conferences. Each of these applications has specific QoS to be met. There is no stationary infrastructure such as base stations in ad hoc networks. Each node in the network is also acts a router, forwarding data packets for other nodes. Moreover bandwidth, energy and physical security are limited. These constraints in combination with network topology make routing protocols in ad hoc networks challenging.

In this paper a systematic performance study of two routing protocols of ad hoc networks, which is distance vector routing protocol DSDV [2] and Dynamic Source Routing DSR [3] is done. Destination Sequenced Distance-Vector (DSDV) routing protocol is one of the first protocols proposed for ad hoc wireless network. It is an enhanced version of the distributed Bellman-Ford algorithm. DSDV is a table driven protocol. 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. DSR has an on-demand behavior, in which they initiate routing activity only in the presence of date packet in need of a route.

This paper discusses the performance evaluation of DSDV and DSR routing protocol which takes the QoS (delay, jitter) and routing load as evaluation metrics.

2. Simulation Model and Evaluation Metrics

The simulator for evaluating routing protocol is implemented with the Network Simulator version 2 (ns2) [4]. Simulation model varies the network size from 10 to 50 nodes placed within 1000m×1000m area. The mobile nodes are stationary. Time required for each simulation 50s.

A. Channel and radio model

Generally there are three propagation models in ns2, the free space model, two-ray ground reflection model and the shadowing model. The free space propagation model assumes the ideal propagation condition where there is only one clear line-of-sight path between the transmitter and receiver. H.T Friss[5] presents the following equation to calculate the received signal power in free space at distance *d* from the transmitter.

$$P_r(d) = \frac{P_t G_t G_r \lambda^2}{(4\pi)^2 d^2 L} \qquad (1)$$

where P_t is the transmitted signal power, G_t and G_r are the antenna gains of the transmitter and receiver respectively, $L(L>=1)$ is the system loss and λ is the wavelength. Generally, $G_t = G_r = 1$ and $L=1$ in ns2 simulations. The free space model basically represents the communication range as a circle around the transmitter. If the receiver is within the circle, it receives all the packets. A single line-of-sight path between two mobile nodes is seldom the only means of propagation.

The two-ray ground reflection model considers both the direct path and a ground reflection path. S. Corson and J. Macker [6] showed that this model gives more accurate prediction at long distance than the free space model. The received power at distance d is predicted by

$$P_r(d) = \frac{P_t G_t G_r {h_t}^2 {h_r}^2}{d^4 L} \qquad (2)$$

where h_t and h_r are the heights of the transmitting and receiving antennas respectively.

The above equation shows a faster power loss than Eq.(1) when the distance increases. However, the two-ray model does not give a good result for a short distance due to oscillation caused by the constructive and destructive combination of the two rays. Instead, the free space model is still used when d is small. Therefore, a cross-over distance d_c is calculated in this model. When $d<d_c$ Eq. (1) is used. When $d>d_c$, Eq.(2) is used . At cross-over distance, Eqs.(1) and (2) give the same result. So d_c can be calculated as

$$d_c = \frac{(4\pi h_t h_r)}{\lambda} \qquad (3)$$

The free space model and the two-ray model predict the received power as a deterministic function of distance. They both represent the communication range as an ideal circle. In reality, the received power at certain distance is a random variable due to multipath propagation effects, which is also known as fading effects. In fact, the above two models predicts the mean received power at distance d.

B. MAC protocol and traffic pattern

The IEEE 802.11 MAC protocol with Distributed Coordination Function (DCF) [7] is used as the MAC layer in our scenarios. DCF is the basic access method used by the mobile nodes to share the wireless channel under independent ad hoc configuration. It uses a RTS/CTS/DATA/ACK pattern for all unicast packets and simply sends out DATA for all broadcast packets. The access scheme is Carrier Sense Multiple Access/collision avoidance (CSMA/CA) with acknowledgements.

A traffic generator named cbrgen was developed to simulate constant bit rate sources in ns2. We use it to generate 6 pair/12 pair/24 pair/30 pair/60 pair of udp stream stochastically. Each CBR package size is 512 bytes and one package is transmitted in 1second.

C. Performance metrics

The following metrics are applied for comparing the protocol performance. Some of these metrics are suggested by the MANET working group for routing protocol evaluation [6].

- Average end-to-end data delay: This includes all possible delays caused by buffering during routing discovery latency, queuing at the interface queue and retransmission delays at the MAC, propagation and transfer times.
- Jitter: the delay variation between each received data packets
- Normalized routing load: the sum of the routing control messages such as HELLO,RREQ etc., counted by k bit/s.

3. Simulation Results and Performance Analysis

A. End to End delay analysis

DSDV protocol exhibits a shorter delay because it is a kind of table-driven routing protocol, each node maintains a routing table in which all the possible 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.

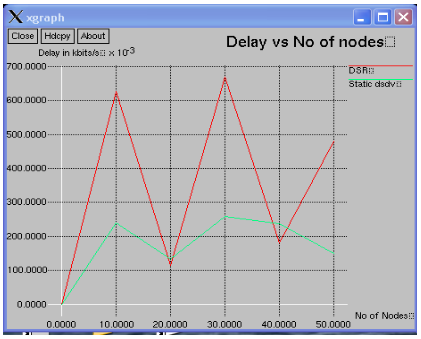

Fig 1. End to end delay versus number of nodes.

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 makes the data packets longer than before. Both of the two mechanism make DSR to have a long delay than DSDV.

B. Jitter Analysis

DSDV is continuous to present the trend of ascending with the size larger than 20. This is depicted in Fig 2.

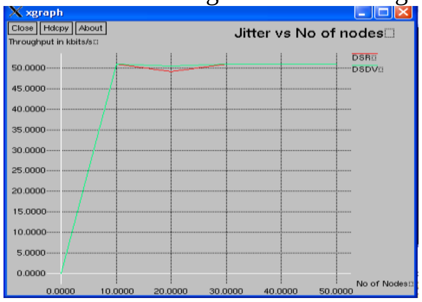

Fig 2. Average jitter versus no of nodes

C. Routing Load Analysis

The routing load of a protocol has influenced node efficiency of battery energy and decided its scalability especially under an environment of narrower bandwidth and easier congestion.

For DSDV the routing load naturally increases at a faster rate along with the number of nodes increasing as shown in Fig.3.

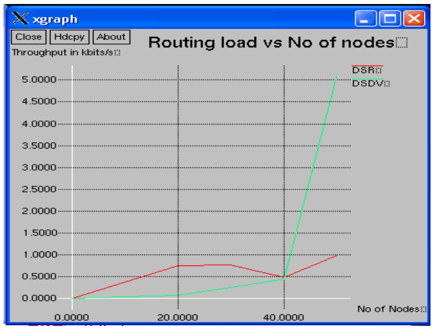

Fig 3. Routing Load versus no of nodes.

Nearly an order of magnitude separates DSR, which has the heavier overhead with the number of nodes smaller than 50.

D. Performance summary

When DSDV must maintain the entire situation information, when topology changes frequently and network size increases, the increment of routing load is very quick, and it is not fit for large scale and high speed moving wireless environment.

DSR routing load is moderate and a long delay which is suitable to a medium scale network environment without higher delay demand.

4. Conclusion

DSDV can be employed in scenario wherein the network topology is known and not dynamically changing. An existing wired network protocol can be applied to ad hoc wireless network with many fewer modifications.

This paper discusses the simulation model for variable network size. This paper contributes in area of impact of different simulation model on routing protocol.

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