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PERFORMANCE EVALUATION OF ON-DEMAND MUTIPATH DISTANCE VECTOR ROUTING PROTOCOL UNDER DIFFERENT TRAFFIC MODELS

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Abstract: Traffic models are the heart of any performance evaluation of telecommunication networks. Understanding the nature of traffic in high speed, high bandwidth communication system is essential for effective operation and performance evaluation of the networks. Many routing protocols reported in the literature for Mobile ad hoc networks(MANETS) have been primarily designed and analyzed under the assumption of CBR traffic models, which is unable to capture the statistical characteristics of the actual traffic. It is necessary to evaluate the performance properties of MANETs in the context of more realistic traffic models. In an effort towards this end, this paper evaluates the performance of adhoc on demand multipath distance vector (AOMDV) routing protocol in the presence of poisson and bursty self similar traffic and compares them with that of CBR traffic. Different metrics are considered in analyzing the performance of routing protocol including packet delivery ratio, throughput and end to end delay. Our simulation results indicate that the packet delivery fraction and throughput in AOMDV is increased in the presence of self similar traffic compared to other traffic. Moreover, it is observed that the end to end delay in the presence of self similar traffic is lesser than that of CBR and higher than that of poisson traffic.

I. INTRODUCTION

MOBILE ad hoc networks are formed by autonomous system of mobile nodes connected by wireless links without any preexisting communication infrastructure or centralized administration. Communication is directly between nodes or through intermediate nodes acting as routers. The advantages of such a network are rapid deployment, robustness, flexibility and inherent support for mobility. Due to their quick and economically less demanding deployment, ad hoc networks, find applications in military operations, collaborative and distributed computing, emergency operations, wireless mesh networks, wireless sensor networks and hybrid networks[1].

Performance of the routing protocols proposed in the literature for MANET differ significantly from one another depending on the type of traffic, mobility model, rate of mobility and no of nodes.The most common stochastic queuing models assume that the interarrival times and service times obey the exponential distribution or poisson distribution. The poisson process is the oldest process that has been used to model interarrival times of traffic streams. With poisson traffic, clustering occur in short term but smoothes out over the long term. A queue may build up in the short run but over a long period, the buffers are cleared out. Hence, only modest sized buffers are needed. This model can describe short length dependence traffic accurately. But it is not adequate to describe the phenomenon of real traffic because of long range dependence in network traffic[2].

Self similarity (SS) is an important property of traffic in high speed network traffic which cannot be normally captured by traditional traffic models. SS describes the phenomenon where certain properties are preserved irrespective of scaling in space or time. The traffic looks the same on all time scale. It is shown in [3] and [4] that data traffic is bursty in nature. One of the main goals of this study is to examine the performance of the existing routing protocols in the presence of SS traffic. The performance of AOMDV is studied under SS traffic and compared with that using other traffic models.

II. TRAFFIC MODELS

A good traffic model may lead to a better understanding of the characteristics of the network traffic itself. This, in turn, can help designing routers and devices which handle network traffic. If, for instance, a model which has been well validated shows some correlation between traffic arrivals, this information can be used in order to conceive strategies for handling packets in an ad hoc network.

A. Self similar traffic or Pareto traffic

It is possible to define SS stochastic processes with heavy tailed distributions. Heavy tailed distributions can be used to characterize probability densities that describe traffic

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processes such as packet interarrival time and burst lengths. The simplest heavy tailed distribution is the PARETO distribution with parameters α and b.

It has been shown in the literature that self-similar or long-range-dependant (LRD) [5][6] network traffic can be generated by multiplexing several sources of Pareto-distributed ON and OFF periods. In the context of a packet-switched network, the ON periods correspond to a train of packets – packets transmitted back to back or separated only by a relatively small preamble (as defined in IEEE standard 802.3, for example). OFF periods are the periods of silence between packet trains. Multiple sources contributing to resulting synthetic traffic trace may be thought of as individual flows (connections). It is reasonable to assume that packet sizes within a connection remain constant. Different connections, however, will have packets of different sizes. To generate a Pareto-distributed sequence of ON periods, one can generate a Pareto distributed sequence of packet train sizes. The minimum train size is 1, which corresponds to a single packet transmitted.

Pareto distribution has the following probability density function:

$$p(x) = \alpha b^{\alpha} / x^{\alpha+1}, x \geq b \qquad (1)$$

where α is the shape parameter (tail index), and b is minimum value of x.

When $\alpha \leq 2$, the variance of the distribution is infinite.
When $\alpha \leq 1$, the mean value is infinite as well.
For self-similar traffic, α should be between 1 and 2. For extremely large values of x, probability of x becomes the higher, lower the value of α

Mean value of a Pareto distribution is given by

$$E(x) = \alpha b / \alpha - 1 \qquad (2)$$

The expression for Pareto distribution is given by

$$X_{PARETO} = b / U^{1/\alpha} \qquad (3)$$

where, U is a uniformly distributed value in the range (0,1]

Very often, it is desirable to generate a synthetic traffic of a predefined load. Obviously, the resulting load *L* is just a sum of loads L_i generated by each individual source *i*, Given N sources, L is given by

$$L = \sum_{i=1}^{N} L_i \qquad (4)$$

Thus, it is important to be able to get a good estimate of the load generated by one source. The load generated by one source is mean size of a packet train divided over mean size of packet train and mean size of inter-train gap. In other words, it is the mean size of ON period over mean size of ON and OFF periods.

B. Poisson traffic [2]

Traffic models based on poisson process originated from telephony where call arrivals could be considered to be independent and identically distributed and holding time follows an exponential distribution. The Poisson process is characterized as a renewal process and is the oldest process that has been used to model inter-arrival times of traffic streams. Poisson process has an exponentially distributed inter-arrival times with rate parameter λ. The probability distribution function is represented as:

$$F(t) = 1 - e^{-\lambda t} \qquad (5)$$

The probability density function is given as

$$f(t) = \lambda e^{-\lambda t} \qquad (6)$$

With Poisson traffic, clustering occurs in short term but smoothes out over the long term. We can design a system of servers and queues with buffers in the expectation of such long-term smoothness. The implication is that, because things smooth out over the long run, only modest sized buffers are needed; a queue may build up in the short run but over a longer period, the buffers are cleared out.

In Poisson like traffic, the aggregate traffic become smoother (less bursty) as the number of sources increases. But actually the burstiness of LAN traffic intensifies as the number of active traffic sources increases, contrary to the common held view. Poisson model is not the appropriate model in case of bursty traffic especially when traffic burstiness happens on multiple time scale[7].

III MULTIPATH ROUTING PROTOCOLS

In MANET, the communication is prone to be broken because of the dynamic topology. High route discovery latency together with frequent route discovery attempts in dynamic networks can affect the performance adversely. Multipath on-demand protocols try to alleviate these problems by computing multiple paths in a single route discovery attempt. Multiple paths could be formed at both traffic sources as well as at intermediate nodes. New route discovery is needed only when all paths fail. This reduces both route discovery latency and routing overheads. Multiple paths can also be used to balance load by forwarding data packets on multiple paths at the same time.
The main idea in AOMDV is to compute multiple paths during route discovery. It is designed primarily for highly dynamic ad hoc networks where link failures and route breaks

occur frequently [8]. When single path on-demand routing protocol such as AODV is used in such networks, a new route discovery is needed in response to every route break. Each route discovery is associated with high overhead and latency. This inefficiency can be avoided by having multiple redundant paths available. Now, a new route discovery is needed only when all paths to the destination break.

IV SIMULATION SETUP

Extensive simulations of the ad hoc network using both AOMDV and AODV are performed under CBR traffic in [8] using Glomosim [9]. The simulated network consisted of 20 nodes randomly scattered in a area 2200m x 600m. Under the same assumptions, performance of the network using AOMDV and AODV under the steady state conditions is studied in this paper, with three types of traffic models namely CBR, Pareto and Poisson[5][6]

CBR model: With this model, the packets are generated at a deterministic rate. Packet size is set to 64 bytes and is generated at a constant rate of 2 kb/s.

Poisson model: The poisson traffic model is an ON/OFF model with inter-arrival times modeled by an exponential distribution. During ON period, the trffic is generated at 2kb/s. Average ON,OFF periods are 315 and 325 ms respectively. The holding time follows an exponential distribution with a mean of 300s.

Pareto model: The Pareto model is also composed of ON/OFF periods. During ON period, the traffic is generated at 2kb/s. Average ON,OFF periods are 315 and 325 ms respectively. The holding time follows a Pareto distribution with a mean of 300s and shape parameter of 1.5. The seed value for the simulation is chosen such that the traffic source generates around 20 source connections which aggregates more data traffic towards the end of simulation causing a burstier traffic to occur. Hence, self similarity can be achieved.

In order to compare the performance of AODV and AOMDV, both protocols are run under identical mobility scenarios. Here, we define the following performance metrics that are evaluated using GloMoSim.

Packet Delivery Fraction: This is the fraction of the data packets generated by the sources that are delivered to the destination. This evaluates the ability of the protocol to discover routes.

Average End-to-End Delay of Data Packets: This is the average delay between the sending of the data packet by the source and its receipt at the corresponding receiver. This includes all the delays caused during route acquisition, buffering and processing at intermediate nodes, and retransmission delays at the MAC layer.

Throughput: Throughput is calculated as the number of data bytes delivered to all destinations during the simulation.

V RESULTS AND DISCUSSION

Through simulation, the Packet delivery fraction for both AOMDV and AODV are obtained and are given in Fig.1. It may be noted that this fraction is larger for AOMDV when compared to AODV. Performance of AODV and AOMDV are similar in the static case. At higher speeds, the fraction of packets delivered goes down for both protocols. However, from Fig 1, it can be inferred that under self similar traffic, packet delivery fraction for AOMDV can be further increased compared to that under poisson traffic.

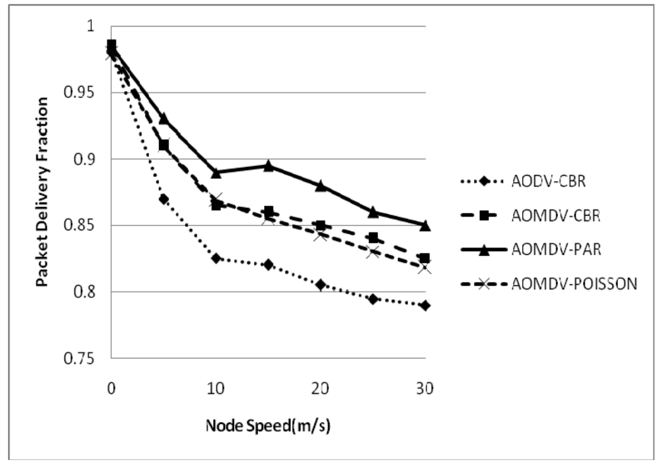

Figure 1. Comparison of AOMDV and AODV in terms of Packet Delivery Fraction

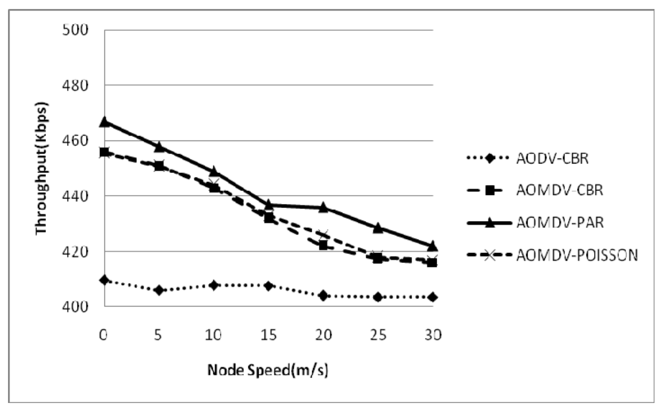

Figure 2. Comparison of AOMDV and AODV in terms of Throughput

Comparison of AOMDV and AODV in terms of Throughput is given in Fig 2. It may be noted that throughput for AOMDV is higher that of AODV for all traffic models. With self similar traffic, throughput of AOMDV is higher than that corresponding to other traffic models. In all the cases, throughput decreases as mobility increases.

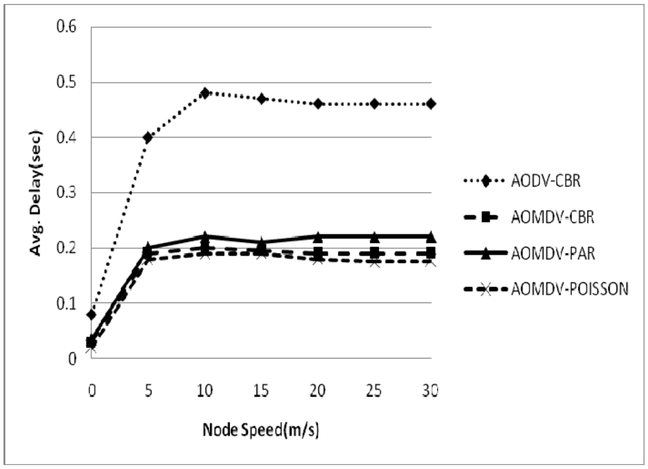

Figure 3. Comparison of AOMDV and AODV in terms of average end-end delay

Average end-end delay using AOMDV and AODV protocols is given in Fig.3. We observe from Fig. 3 that the average end to end delay variation of AOMDV in all the three cases of traffic models is almost same.The delay in AOMDV is very less compared to AODV. This is because of the availability of alternate routes on route failures which eliminates the route discovery latency that contributes to the delay.

VI CONCLUSIONS

This paper evaluates the performance of AOMDV and AODV in the presence of CBR, Poisson and self similar traffic models by simulation using Glomosim with nodes moving at speeds ranging from 0-30 m/s. We observe that under self similar traffic AOMDV offers a significant improvement in packet delivery fraction and throughput compared to other two traffics. Further, the average end to end delay variation of AOMDV in all three cases of traffic models is almost same.

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