International Refereed Journal of Engineering and Science (IRJES)
ISSN (Online) 2319-183X, (Print) 2319-1821
Volume 6, Issue 10 (October 2017), PP.20-23

Stochastic Techniques for Manet's Performance Prediction Analysis

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ABSTRACT:- Over the years, Mobile Ad Hoc Networks (MANETs) are foremost necessary form of circumstantial wireless network, where mobile nodes join together on an extemporaneous basis. MANETs are both self-healing and self-forming, and let the communications begin between mobile nodes peer to peer level with no support of fixed infrastructure or federal administration. These attributes of MANETs bring vital advantages in a circumstances that features vastly mobile users or platforms, ought to share IP-based information, or a situation where fixed network infrastructure is supposed to be impractical, impaired, or extremely complex to laid down, which gives rise to more concern about performance of MANET. In this paper we developed a stochastic technique also known as queueing approach for MANET which evaluates some of the performance metrics.

Keywords:- MANET, Performance evaluation, Queueing approach, Stochastic Process, Delay.

Date of Submission: 14 -10-2017 Date of acceptance: 02-11-2017

I. INTRODUCTION

A Stochastic Process is a family of random variables indexed by the parameter t in T [1]. For a given choice of the time instant t, different realizations of the stochastic process will generate random values of X at the selected time instant t. We consider the the stochastic process X(t) to take on the random values $X(t_1)=x_1$,......, $X(t_n)=x_n$,.......at times t_1,....,t_n,....... The random variables x_1,........, x_n,........ are then specified by specifying their joint distribution. One can also choose the time points t_1,....,t_n,....... where the process is actually examined in different ways [2].For our purposes, we need to consider a specific type of stochastic process where past history of the process can be neglected if one knows the current state of the process. This property is referred to as the Markov property. Apart from the fact that this property can be naturally observed in many processes, assuming this also makes the analysis reasonably tractable in the case where we want to study queues and queueing networks.One of the most significant stochastic model is queuing model which is easier and cheaper to develop and use. Additionally, in view of the fact that these are very fast to run and simple to carry out "what-if" analysis. They determine tradeoffs and find engaging solutions instead of simply estimating performance for a wireless network [9][17].

With the proliferation of MANET everywhere, to satisfy the requirements of the users, performance will remain a cardinal point of discussion for the researchers and academicians [21-23]. An environment where the devices keeps on adapting and reconfiguring themselves individually and jointly, is more prone to Quality of Services (QoS) related issues [3-8]. For the queueing models, we can obtain the new formulas and derivations that determine the estimation of performance measures in the MANET to help out designing a latest service system or we can make better the existing one [10][18]. Queueing model is a mathematical depiction of a queuing system that builds some pinpoint assumptions regarding the probabilistic environment of the entering and service activities within the network, the quantity and nature of servers, additionally packet waiting discipline. The foremost general assumption concerning arrivals to build is that they follow a Poisson process [11-13]. Thus, let us say P(t) is the total arrivals at a node in the network during the time interval of length t and P(t) follow a Poisson distribution, then

$$\text{Probability } \{P(t) = n\} = e^{-\lambda t} (\lambda t)^n / n!$$

where λ is termed as the arrivals rate of the packets on the node in the network.

II. DESCRIPTION OF THE MODEL

The model M/M/1/K/K is considered to have a single queue of size k. This is also known as a finite population model of population size k where packets arrive according to a Poisson distribution (with mean rate λ per unit time) and the service duration follows an exponential distribution (with service time $1/\mu$) [14][19]. All the packets wait in the queue of the node till their service is finished completely in order to depart from the MANET.

$$\lambda_{eff} = (K-n)\lambda$$
$$\mu_n = \mu$$

For the network to be stable, $\lambda < \mu$. In any case if arrivals occur faster than the service finished, the queue grows unlimitedly long-lasting and therefore the network won't have a stationary distribution. This distribution is said a limiting distribution for big values of t. No more than K packets reside in the queue at any point of time.Various performance measures and parameters are computed explicitly for the M/M/1/K/K queue by determining closed form expression. We tend to write $\rho = \lambda/\mu$ for the use of buffer and need $\rho < 1$ for the stable queue. ρ represents the typical proportion of time that the server is occupied. The state transition diagram of M/M/1/K/K is shown in the figure 1. The model is better suited for approximating the real time system since memory space is always limited [15][20].

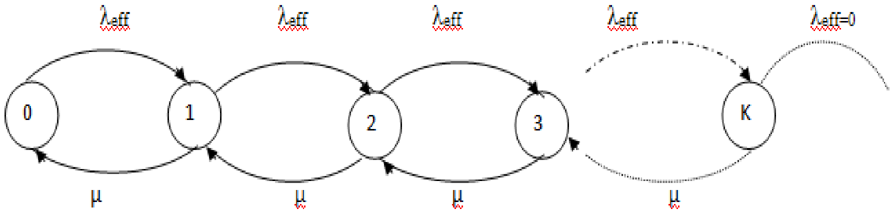

Figure 1: State transition rate diagram

The Probability of having n packets in the queue at any time is represented as

$$P_n = P_0\ \rho^n\ \frac{!K}{!K-n} \qquad 0 \leq n \leq k$$

If P = 0 otherwise (Sum of all probabilities)

$$\sum_{n=0}^{k} p_n = 1$$

Hence the probability that the system is empty is given by

$$P_0 = \frac{1}{\sum_{n=0}^{k}[\frac{!K}{!K-n}\rho^n]}$$

Expected number of packets in the system

$$L = E(n) = \sum_{n=0}^{k}(n.P_n) = \frac{\rho}{1-\rho} - \frac{(K+1)\rho^{K+1}}{1-\rho^{K+1}}$$

Where P_n is the probability that there are n packets in the queue.

III. PERFORMANCE MEASUREMENTS OF THE MODEL

Queuing models are bound to predict the performance measurement in MANETs in order to enhance the Quality of Service (QoS) which is most crucial and unsettled issue [16]. The following measurements are taken under discussion in the paper.

3.1 **Average waiting time in the system** (Sojourn time in the system)

$$W = L / \lambda_{eff}$$

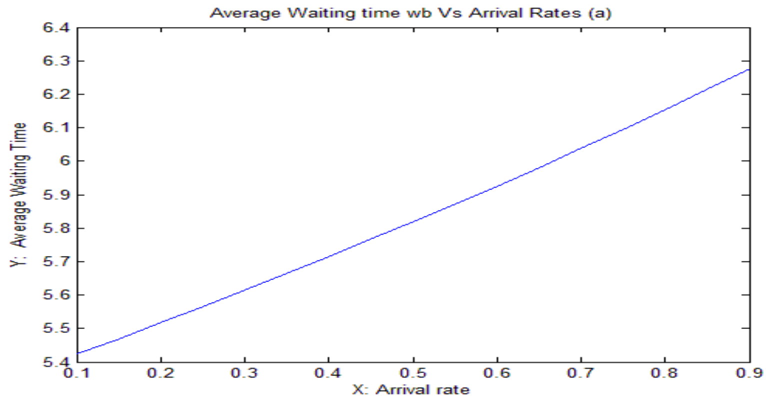

Fig. 2: Graph Between Average Waiting Time And Arrival Rate

3.2 Expected number of packets in the queue

$$L_q = L - \lambda_{eff} /\mu = = L - (k\text{-}n)\lambda /\mu$$

3.3 Server utilization is given by

$$\rho = \lambda_{eff} /\mu$$

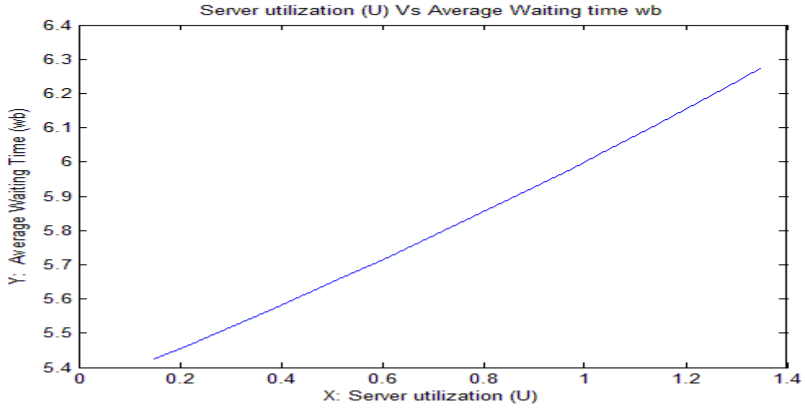

Fig. 3: Graph between Server utilization and Average waiting time

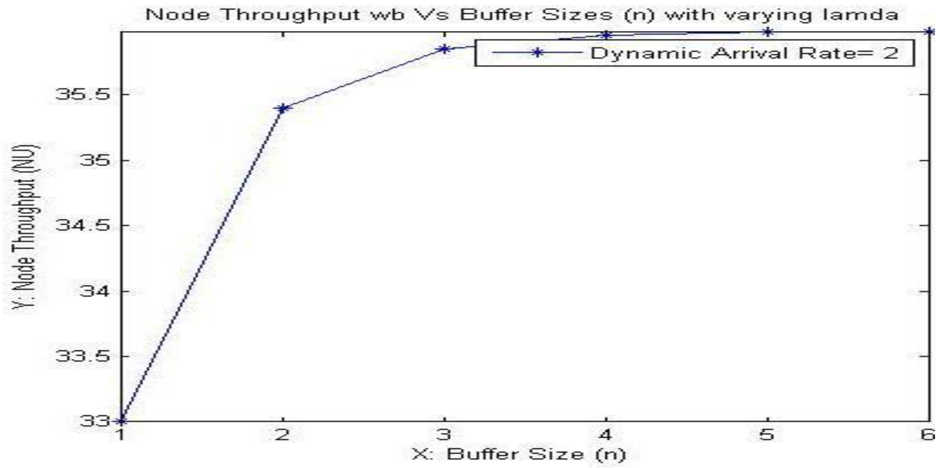

Fig. 4: Graph between Node throughput and Buffer Size

IV. OUTCOMES

Results are obtained using MATLAB. The figure 2 presents the result of queueing waiting time for the arrival rate for the fixed service rate in the network. The graph shows a positive relationship between them where increment in the arrival rate is associated with the increment in the average waiting time in the network. In figure 2, we can see that server utilization is increasing with increasing the average waiting time. The figure 4 presents the node throughput which bound to increase with increasing value of Buffer Size in the network. This is also showing a positive relationship.

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