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QUALITY ESTIMATION ANALYSIS OF DATA TRAFFIC IN NETWORKS WITH CONTROLLABLE ARRIVALS

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In recent Years there has been an increasing research interest in supporting Quality-of-Service (QoS) for multimedia application in wireless networks. Different resources allocation and call-admission control schemes have been proposed to reduce the call-blocking probability and/or throughput. Since ATM involves a statistical multiplexing scheme, queuing delays, cell loss or other degradation of Quality of Services (Qos) may easily occur in cases of network congestion. Bursty traffic, such as image data transfer, has a particular service impact on communication quality because of statistical load fluctuations. Traffic control is thus necessary to avoid congestion. Traffic control methods may be divided into two categories (reactive control and preventive control and the most sufficient use on network resource may be achieved by combining the two. All admission control is, of course a form of preventive control, which is by nature more efficient than reactive control for use in high-speed networks wood88].

1. Introduction

In recent Years there has been an increasing research interest in supporting QoS for multimedia application in wireless networks. Different resources allocation and call-admission control schemes have been proposed to reduce the call-blocking probability and/or throughput [Chen04a, Chen04b, Mark2000, Fang02, Mall03, Haun02, Holm01, Xiao02, Haun04, Yao04, Wong04]. Since ATM involves a statistical multiplexing scheme, queuing delays, cell loss or other degradation of quality of services (Qos) may easily occur in cases of network congestion. Bursty traffic, such as image data transfer, has a particular service impact on communication quality because of statistical load fluctuations. Traffic control is thus necessary to avoid congestion.

Traffic control methods may be divided into two categories (reactive control and preventive control and the most sufficient use on network resource may be achieved by combining the two. All admission control is, of course a form of preventive control, which is by nature more efficient than reactive control for use in high-speed networks wood88].

The asynchronous transfer mode (ATM) has been widely recognized as a promising solution for the implementation of broadband ISDN (B-ISDN). The ATM technology is attractive for designing a broadband ISDN to handle integrated traffic ranging from narrowband voice and data traffic to broadband video. Input traffic management and congestion control scheme with marking method can improve service quality and network throughput [Hand89,kawa88,Hira89].

To solve the optimal admission control problem in queueing networks, a standard approach is to first formulate the optimization problem as a Markov decision problem or a semi-Markov Decision problem [Rosb82] have also been used. Call admission control determines whether or not to accept a call in order to achieve required Quality of Service (QoS) such as delay and cell loss probability. A call admission control, thus must handle the traffic which the user has declared, and also estimate the QoS.

2. Research Methodology

In this paper, we have developed a queueing model in which arrivals and service are correlated and is named as interdependent queueing model. It provides the basic framework for efficient design and analysis of many practical situations. The operating strategy employs two integral values r (the normal, arrival rate) and R (the peak arrival rate) for a system. In general, waiting line of a quening model increases due to slow service rate or fast arriving rate. The strategy is to control the arrival rate for a system. We have considered the arrival and services processes of the multiple server queueing system which are correlated and follow a bivariate Poisson distribution having the joint probability generating function with parameters: mean arrival rate λ_l (l = 0) where, l = 0 represents the normal arrival rate situation of packets and l = 1 represents the peak arrival rate situation, respectively. Mean service rate of the arrived unit in the system is represented by μ. We obtained

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probability function to analyze system behaviour in terms of packet loss probability and conditional probability.

3. Model Description

We develop a queueing model of M/M/c with transient behavior with the assumption that the arrival and service process of the system are correlated and follow a bivariate Poisson distribution. P(0) represents the probability that the system is in the state I (I = 0, i.e. state 0 is normal arrival rate and state 1 is for peak arrival rate). In addition to this interdependence whenever the queueing size reaches to a certain prescribed limit R, the arrval rate reduces from λ_1 to λ_0 and it continuous with the reduced rate λ_0 as long as the number of customers in the queue is greater than prescribed integer r (0 < r < R) and when the system reaches R, the arrival rate changes back to λ_0 and the same process is repeated.

The parameters used are mean arrival rate λ_I(I = 0,1) mean service rate m and mean dependency rate e (covariance between the arrival and service processes), respectively. The operating strategy of the system is controllable arrival rates with prescribed integers R and r.

4. Model Analysis

Transient State equations (M/M/c queueing Model with Controllable arrival rate) are as given below:

$$P_0(0) = -(\lambda_0 - e)\,P_0(0) + (\mu - e)\,P1(0) \qquad (1)$$

$$Pn(0) = -\ (\lambda_0 + n\mu - (n+1)e)P_n(0) + (\lambda_0 -\ e)\ P_n{-1}(0) + (n+1)\,(\mu - e)\,P_n + 1(0)\ 1< n< c -1 \qquad (2)$$

$$P_n(0) = -\ (\lambda_0 + n\mu - (c+1)e)Pn(0) + (\lambda_0 - e)\ P_n1(0) + c(\mu - e)\,P_{n+1}(0)\quad c < n < r - 1 \ (3)$$

$$P_n(0) = -\ (\lambda_0 + c\mu - (c+1)e)P_r(0)_+(\lambda - e)\ P_{r-1}(0) + c\,(\mu - e)\,P_r + 1(0) + c\quad 1 < n < c - 1c\,(\mu - e)P_{r+1}(1)$$

Definig boundary condition for state 0,

$$P_0(0) = -sPn - 1(0)$$

From equation (1), we get

$$P_0(0) = -(\lambda_0 - e)\,P_0(0) + (\mu - e)\,P1(0)$$

Taking Laplace Transformation, we get

$$sP_0(0) - P_0(0) = -(\lambda_0 - e)\,P_0(0) + (\lambda - e)\,P1(0)$$

From Equation (2), we get

$$P_n(0) = -(\lambda_0 + n - (n+1)e)P_n(0)_+(\lambda_0 - e)\ P_{n-1}(0) + (n+1)(m - e)P\,n + 1(0)\quad 1< n < c - 1\ (2)$$

Taking Laplace Transform, we get

$$sP_n(0) - P_n(0) = -\ (\lambda_0 + n\mu - (n+1)e)\ Pn(0) + (\lambda_0 - e)\ P_{n-1}(0) + (n+1)\,(m - e)\,P_{n+1}(0)$$

$$-\ (\lambda_0 + n\mu - (n+1)\,e + s)\,P_n(0) = (\lambda_0 - e)\,P_{n-1}(0) + (n+1)\,(\mu - e)\,P_{n+1}(0) + sP_{n-1}(0)$$

Now Putting n = 1 in the equation (2), we get

$$2P_2(0) = \frac{[(\lambda_0 + \mu - 2e + s)]}{(\mu - e)} - \frac{P1(0)[(\lambda_0 - e + s)P_0(0)}{(\mu - e)}$$

$$2P_2(0) = \frac{[(\lambda_0 - e + \mu - e + s)]P_1(0) - (\lambda_0 - e + s)P_0(0)}{(\mu - e)\,(\mu - e)}$$

$$\frac{-(\lambda_0 - e + s) - P_0(0)}{P_0(0) - (\mu - e)}$$

Now, Putting n = 2 in the equation (2), we get

$$3P_2(0) = \frac{(\lambda_0 + 2\mu - 3_{e+s}) - P_2(0)}{(\mu - e)}$$

$$-\ \frac{(\lambda_0 - e + s)P_0(0) - p_1(0)}{(\mu - e)}$$

Taking lap lace transform, we get

$$sP_r(0) - P_r(0) = -\ (\lambda_0 + c\mu - (c+1)e)P_r(0) + (\mu_0 - e)\ P_{r-1}(0) + c(\mu - e)P_{r+1}(0) + c\ (\mu - e)\ P_{r+1}(1)$$

From equation, we get

$$P_{r+1}(1) = -\ (\lambda_1 + c\mu - (c+1)e)P_{r+1}(1) + C(\mu - e)\ P_{r+2}(1)$$

Taking Laplace Transform, we get

$$sP_{r+1}(1) - p_{r+1}(0) = -(\lambda_1 - c\mu - (c+1)e)p_{r+-1}(1) + c(\lambda - e)P_{r+2}(1)$$

similarly, we get the following equations,

$$P_n(1) = \frac{P_{r+(n-r)}(1) = P_{r+1}(1)}{r + 1 \le n \le R}\ \frac{1 + (H + H)^{n-r}}{(1 - (H + H)}$$

The Condition Probability that the system is in state-0 (normal arrival rate) is given below.

$$= P_0(0/r \le n \le R) = \frac{\sum_{n=r}^{R-1} Pn(0)}{P(r \le n \le R)}$$

Quality Estimation Measure: Packet Loss probability (at peak arrival rate)

In this model, arriving pattern is controllable and we have taken cases when packet arrival rates are between normal rate and peak rate. Here, it is assumed that, when the number of arriving packets in the queue increases and tends towards r it will be changed in loss of packets. When arrival rate reaches to r then the controllable system reduces it to λ_0. In active periods, packets are generated at a constant rate

MAX, the peak rate. In the idle periods, no packets are generated. The number of packets generated in an active period is denoted by N, and AVG is the mean rate. In this model quality is measured in terms of packet loss probability, which is based on a link overflow model, which is derived from the traffic characteristics parameters MAX and AVG. As we mentioned earlier, overflow can occur when arrival rate reaches to R, packet loss probability P(I) in the model is the ratio of ET(excess Traffic) and ρ (traffic load):

Packet Loss Probability

$$P(I) = \frac{ET}{\rho}$$

$$ET = GF^{R}(1-F)/(1-H+H))\ (R-r) - \ (H\_H)^{n}$$

$$1-GF^{R}\ (R-r)(F-(H+H)) + 1-F\ (H+H)^{n}$$

$$(1-F)\ 1-(H+H)\ \ 1-(H+H)$$

Where, n is the number of packets during active period i.e. at peak rate Hence,

5. CONCLUSION

In this paper we estimated Quos of high speed networks with controllable arrivals. The model is applicable in the scenarios where there are limited options available or service i.e. the situation where one cannot increases the number of servers or the capacity of the servers but one can control the arrivals. We have developed an interdependent queuing model correlated with arrivals and service disciplines. The performance of the model is measured in terms of packets loss probability. We have established a relation between Packet Loss Probability and maximum Arrivals Rate. It is observed from that the Packet loss probability increases as the mean arrival rate of packets increases. Further, it is also observed from the graph that initially packet loss probability increases with the arrival rate but as soon as arrival of packets reaches to a certain prescribed limit R, interdependent process system controls the arrival of packets b a check on packet loss probability as it tends to exhibit steady behavior.

6. SCOPE AND SUGGESTIONS FOR FUTURE INVESTIGATION

As the performance evaluation of high-speed data networks has several dimensions, it was not possible to take care of all the aspects. In the present work some issues need further attention. In this we derived the expressions for mean packet delays of two types of traffic arrivals. Taking more traffic arrivals with interruption server mode can further extend of this model. Since in the present communication scenario multiply system (Integrated Digital Networks) is excessively used for real-time systems, therefore, the extension of the model can create a framework for future research.

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