Avoid Delay of Packets and Improve the Behavior of Switch/Router under Self-Similar-Type Variable Input Traffic

Anand Dohare[1], B.Mallikarjuna[2], Tulika[3], D. Arun Kumar Reddy[4]
Mohd.Shahjad[5], D. Mallikarjuna Reddy[6]
[1]*Research Scholar, SHUATS University, Allahabad, India-211007*
[2]*School of Computing Science & Engineering, Galgotias University, Greater Noida, Uttar Pradesh, India-201310, basetty.*
[3]*Assistant Professor, SHUATS University, Allahabad, India-211007*
[4]*Research Scholar, Bharathiar University, Coimbatore, Tamil Nadu, India-641 046*
[5]*Research Scholar, Uttarakhand Technical University, Dehradun, 248007*
[6]*Assistant Professor, GITAM University, Hyderabad, India-502 329*

Abstract *— This paper analyzes the switch/router under self-similar variable traffic with delay behavior on switch/router and the improvement in the performance of packet traffic under self-similarity nature of long-range dependency (LRD). The LRD property degrades the router performance. Consequently, it is essential for buffer conception of a switch in communication engineering technology. In this study, by taking into account voids, we examine the switch under self-similar input traffic. We simulated this model using queuing model and the MMPP (Markov-Modulated Poisson Process) and observed the variance in MMPP under self-similar traffic. We investigated traffic metrics, fitting specification and mean delay, which demonstrated improvement in the performance of switch/router.*

Keywords **—** *MMPP, self-similar traffic, LRD, voids, mean delay, traffic intensity.*

I. INTRODUCTION

It observed that packet traffic principles of long-range dependent LAN and WAN are self-similar [1]. The qualities of service (QOS) parameters are numerous; however, we focused on packet delay and packet loss probability on routers and switches [2]. The Markovian Arrival Process (MAP) has been implemented in self-similar traffic [3]. MMPP is useful for calculating the probabilities at the time of packet transmission; hence, MMPP is a particular case of MAP, and interrupted poison process (IPP) has been implemented as a special case of MMPP [4]. The associate perception of MAP is Markov Modulated Poisson Process (-MMPP), where is superposition, having 2-state IPP. -MMPP contains the second-order statistics of MMPP and the self-similar traffic over desired time scales [5].

The switch and router have packet loss probability and mean packet delay with input or output traffic, the two main QoS parameters. L.P. Raj Kumar and K. Sampath Kumar (2010) designed queuing technique. it follows the principle of hurst index and traffic intensity [6]. It is examined by both analytical and simulation results. Packet lengths are assumed to follow exponential distribution [7]. But when the packet length varies, voids occur in the switch buffer and the performance of the switch degrades because voids incur excess load [8]. This issue is not addressed in other studies [6, 7]. In the study[8], packet arrivals are assumed to follow Poisson distribution which is proved to be unrealistic [9]. Here we are concerned with the performance of switch by applying the queuing technique, taking voids into account.

The rest of the paper describes the overview of self-similar processes, section 2 describes the related work on MMPP and then queuing method. Section 3 is about modelling of switch for variable length packets in buffers. Section 4 is on effective results being carried out by the queuing system, the packet loss probability and means waiting time and demonstrates the effects of parameters such as Hurst index, traffic intensity, number of components in superposition, and time scales. Section 4 concludes.

II. RELATED WORK

Krishna P.V, Misra S, Oaidat MS, Saritha V, N. Ch. S. N Iyengar (2009) proposed a sequencing technique on 802.11medium access control that improves the performance of wireless networks [19]. This method consists of two techniques: Request To Send (RTS) or Clear To Send (CTS). RTS/CTS method avoids wastage of the bandwidth, which is achieved by sequencing [18]. They proved this technique using NS2 toolkit. In mobile computing, QoS is required for channel allocation; and effective communication needs frequency spectrum that provides effective bandwidth spectrum [17]. They proposed QoS parameter hand off calls and drop off calls, maintaining queues for all types of calls [16].

They could not focus on communication devices such as switch and router. There is a necessity to improve the effective communication strategy on switch/router [15]. The network traffic on switch/router contains delay of packets and some of the malicious packets are dropped. It requires apply effective strategy for legitimate traffic, as shown in figure 1.

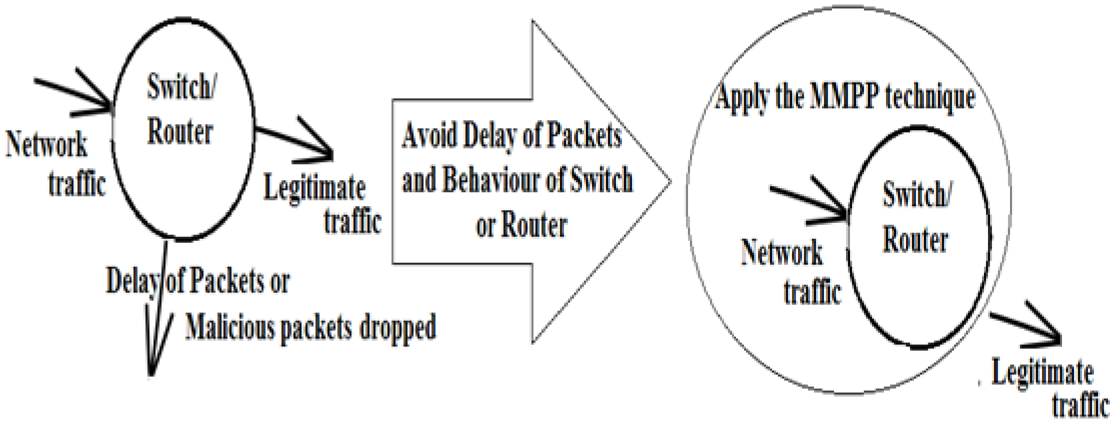

Figure 1: Model for switch or router in the network

Self-Similar Traffic - Markov Modulated Poisson Process (SSTMMPP) follows second-order self-similar process.

Algorithm 1: SSTMMPP Algorithm

Step 1: Let Y is a second-order stationary process with variance σ^2, it divides the different time intervals [14]

$Y = \{Y_t / t = 1,2,3........\}$, if the packet arrived at t^{th} interval, then $Y^{(n)} = \{Y_t^{(n)}\}$, where $Y_t^{(n)} = \frac{1}{n}\sum_{i=1}^{n} Y_{(t-1)n+i}$, $t =$ 1, 2, 3..... , m is the average original sequence for overlapping packets. Then Y is the exact second-order self-similar process with the Hurst parameter, $\Gamma = 1 - \delta / 2$, if

$$Var(Y^{(n)}) = \sigma^2 n^{-\beta}, \quad \forall n \geq 1. \quad (1)$$

Step 2: There is doubly stochastic process as per Morkovian Modulated Poison. This process in which the arrival rate is given by $\chi[J_t]$,

here $J_t, t \geq 0$ is an n-state Markov process[13]. The arrival rate can therefore take on only n values, namely, $\chi_1, \chi_2, ..., \chi_n$. It is equal to χ_j whenever the Markov process is in the state j, $1 \leq j \leq n$.

Let Assume Γ be the diagonal matrix with $\Gamma_{jj} = \chi_j$, $1 \leq j \leq m$. In the case of two states, Q and Γ are given in equation 2. The MMPP is fully parameterized by the infinitesimal generator Q of the Markov process and the vector $\chi = (\chi_1, \chi_2, ..., \chi_m)$ of the arrival rates [12] .

$$Q = \begin{bmatrix} -S_1 & S_1 \\ S_2 & -S_2 \end{bmatrix} \quad \Gamma = \begin{bmatrix} \chi_1 & 0 \\ 0 & \chi_2 \end{bmatrix}. \qquad (2),$$

Step 3: χ is the mean arrival rate of MMPP, which is given by $\chi = \vec{\pi}\Gamma e$, here

Q is the stationary probability vector contains $\vec{\pi}$, where $\vec{\pi}Q = 0, \vec{\pi}e = 1$ and e.

It contains -1 of designated dimension column vector. If we let N_t, t ≥0, in the interval (0, t] contains the number of arrivals, for the stationary MMPP, the mean of N_t is:

$$\frac{S_2\chi_1 + S_1\chi_2}{S_1 + S_2} tmean = \mu = E[N_t]. \qquad (3)$$

The variance of N_t is:

$$E[N_t] + \frac{2S_1S_2(\chi_1 - \chi_2)^2}{(S_1 + S_2)^3} t - \frac{2S_1S_2(\chi_1 - \chi_2)^2}{(S_1 + S_2)^4}[1 - e^{-(S_1+S_2)t}] = Var[N_t] = \sigma^2. \quad (4)$$

.

III. SELF-SIMILAR TRAFFIC MMPP/M/1/K QUEUING METHOD

In queuing system, asynchronous switch followed the self-similar structure of variable length packet input traffic is modeled. In system, the packets are allowed into the switch MMPP of states which can be written as matrix representation , where are matrices[11]. The self-similar traffic

Markovian-modulated Poisson process (MMPP) MMPP/M/1/K following algorithm.

Algorithm 2: MMPP/M/1/K Algorithm

Step 1: μ is the rate of service exponential value. It defines $n \times n$ which is the order of matrix E_l, $l \geq 0$ contains (i, j) elements, the probability of packets at the time of departure is 0. At the initial stage, one departure state is i, the next departure state is j and k is a throughput of the arrivals. E_k is defined as follows [10].

$$\sum_{l=0}^{\infty} E_k z^k = \mu \int_0^{\infty} e^{[Q-\Gamma+\Gamma z]x} e^{-\mu x} dx \quad (5)$$

$$\sum_{l=0}^{\infty} E_l z^l = \mu\left(\mu I - (Q - \Gamma + \Gamma z)\right)^{-1}$$

$$\sum_{l=0}^{\infty} D_l z^l = \mu^2 \sum_{l=0}^{\infty} \left(\frac{Q-\Gamma+\Gamma z}{\mu}\right)^l, \quad (6)$$

Step 2: Let I be the unit matrix chosen by the dimension. Equation 6 extends the distribution exponential service , where in equation (6) can be written as:

$$E_0 = \mu^2 \left(I + \sum_{r=0}^{\infty} \left(\frac{Q-\Gamma}{\mu}\right)^r \right). \quad (7)$$

For $l, n \geq 1$, let $T(n,l)$ be the coefficient of z^{l-1} in $\mu^2 \left(\frac{Q-\Gamma+\Gamma z}{\mu}\right)^n$, n^{th} from the equations (6) and (7), which can be written as:

$$T(1,1) = \mu^2 \left(\frac{Q-\Gamma}{\mu}\right), \qquad T(1,2) = \mu^2 \frac{\Lambda}{\mu}$$

$$T(n,1) = \mu^2 \left(\frac{Q-\Gamma}{\mu}\right)^n, T(n,l) = 0, \text{ if } l > n+1,$$

And

$$T(n,1) + T(n,2)z + T(n,3)z^2 + \ldots\ldots\ldots + T(n,l)z^{l-1} + \ldots\ldots + T(n,n+1) = \mu^2 \left(\frac{Q-\Gamma+\Lambda z}{\mu}\right)^2$$

$\mu^2 \left(\frac{Q-\Gamma+\Gamma z}{\mu}\right)$, it obtains the series of equation as follows:

$$[T(n,1) + T(n,2)z + T(n,3)z^2 + \ldots + T(n,l)z^{l-1} + \ldots + T(n,n+1)z^n]\mu^2 \left(\frac{Q-\Lambda+\Lambda z}{\mu}\right)$$
$$= T(n+1,1) + T(n+1,2)z + \ldots\ldots\ldots$$

Associate the coefficients of power of z and then

$$T(n+1,1) = T(n,1)\mu^2 \left(\frac{Q-\Gamma}{\mu}\right),$$

$$T(n+1,2) = T(n,2)\mu^2 \left(\frac{Q-\Gamma}{\mu}\right) + T(n,1)\mu^2 \frac{\Gamma}{\mu},$$

$$T(n+1,q) = T(n,q)\mu^2 \left(\frac{Q-\Gamma}{\mu}\right) + T(n,q-1)\mu^2 \frac{\Gamma}{\mu} \quad (8)$$

$q \in \mathrm{N}$. Equation (9) is formed to date the equations (6), (7), and (8)

$$E_s = \sum_{k=s}^{\infty} T(k, s+1), s = 1,2,.. \quad (9)$$

Step 3: The recurrent relation matrix R from equations 7, 8, and 9 have recurrent relations lead to obtaining equation 10. Then we framed Markov chain of each packet that arrived in the switch or router $\{L(n), J(n) / n \geq 0\}$ at the leaving epochs of the packets departure rate in the queue arrangement $MMPP / M / 1 / k$, and $J(n)$ denotes the situation is MMPP, the packets arrived in the entire state space $S = \{(b,i) / 0 \leq b \leq K-1, 1 \leq i \leq m\}$, where $L(n)$ denotes buffer tenancy:

$$R = \begin{bmatrix} HE_0 & HE_1 & \ldots & HE_{K-2} & HF_{K-1} \\ E_0 & E_1 & \ldots & E_{K-2} & F_{K-1} \\ 0 & E_0 & \ldots & E_{K-3} & F_{K-2} \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ 0 & 0 & \ldots & E_1 & F_2 \\ 0 & 0 & \ldots & E_0 & F_1 \end{bmatrix} \quad (10)$$

Equation (10) matrix R provides each packet pertaining under self-similar variable embedded Markov chain that transition to probability matrix where $H = (\Gamma - Q)^{-1}\Gamma$, consisting of conditional probabilities that system is not busy and

$F_i = \sum_{l=i}^{\infty} E_l$. Let $\overrightarrow{y_k}$, $(0 \leq k \leq K-1)$ be an $1 \times n$ vector whose i^{th} element is the number of packets in the system, k is a stationary conditional probability and i is the packet that arrived at random. At the end, the packet loss probability (PLP) has been defined [11] is

$$PLP = 1 - \frac{\left(1 - \overrightarrow{y_0} e\right)}{\rho} \quad (11)$$

where $\rho = \frac{\lambda}{\mu}$, traffic intensity and λ is the mean arrival rate of MMPP where

$$\lambda = \vec{\pi} \Lambda e.$$

A. Modeling of Switch for Variable Length Packets in Buffers

In this segment, we consider the switch buffer for uneven extent packets. In this buffering arrangement, the second packet arrives at the time when the first one is transmitted. In order to avoid disputation, the second packet is to be deferred by physical mechanism, namely, fiber delay lines (FDL). Let the first packet arrive at the system at time t, tf is the time at which the packet is transmitted and this packet will be delayed by an amount of time tf -t. In the ocular buffer system, the delay time must be a consecutive multiple of delay line unit (DLU) denoted by D as shown in the Fig. 1. Hence, the actual delay time, (say) becomes larger than tf – t and is given by.

$$\Delta = \left\lceil \frac{t_f - t}{D} \right\rceil D, \qquad (12)$$

where $\lceil x \rceil$ represents the smallest integer not greater than x. Therefore, $\tau = \Delta - t_f + t \geq 0$ is the time interval when the system is idle. The waiting time τ is called void which automatically increases when the packet length increases; hence, it degrades the system performance. Several methods have been proposed to resolve this problem. The possible method is the void filling scheme[16, 20, 21]. In this context, appropriate models using both infinite and finite queuing systems are proposed by Callegati [8]. In the said models, input traffic is assumed to follow Poisson process which is not realistic, because Poisson process cannot emulate the self-similar nature of the traffic. Instead, we have an $MMPP/M/1/k$ queuing system to analyze the switch.

We assume that actual packet length ν follows exponential distribution with parameter μ and $\bar{\nu}$ its average. Let ν_e be the excess length and $\bar{\nu}_e$ be its average. We assume that void length τ follows rectangular distribution and takes the values between 0 and D. Therefore, its average is $\bar{\tau} = \frac{D}{2}$.

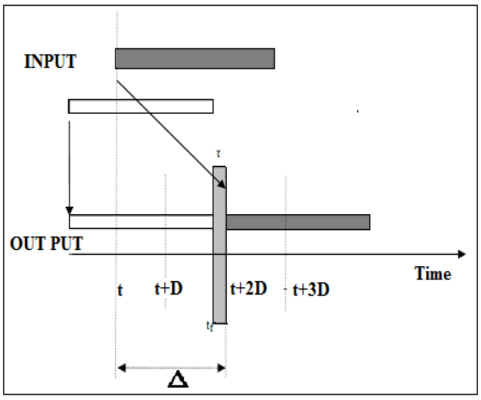

Figure 2: Illustration of Queuing in a FDL buffers

we derive equation (13) from equation (12).

$$\bar{\nu}_e = \bar{\nu} + (1 - PLP)\pi_q \frac{D}{2} \qquad (13)$$

where π_q is the probability that a packet not lost is queued. The traffic intensity in this case would be $\rho_e = \lambda \bar{\nu}_e$ and this ρ_e is called excess load. We know that if X is exponential and Y is uniform, then the density of $Z = X + Y$ is given by

$$h(z) = \begin{cases} 0 & z \leq 0 \\ 1 - e^{-z} & 0 \leq z \leq 1 \\ (e-1)e^{-z} & z \geq 1 \end{cases} \qquad (14)$$

Hence, the excess length ν_e is not exponentially distributed, but it has the density function given above that would greatly increase the complexity in (5). For this reason, we assume that packet length distribution follows exponential with parameter $\mu_e = \frac{1}{\bar{\nu}_e}$, this simplifies the problem and we have $\rho_e = \frac{\lambda}{\mu_e}$.

In the case of $MMPP/M/1/k$ queuing system, we have $\pi_q = 1 - (1 - \rho) = \rho$

As discussed in [7], starting with ρ, the packet loss probability PLP can be calculated using eqn (11). Using this PLP, $\bar{\nu}_e$ can be computed using eqn. (13). Finally, the mean delay (w) is given by

$$w = \bar{\nu}_e \sum_{k=1}^{\infty} k(\vec{y}_k\, e). \qquad (15)$$

IV. RESULTS AND DISCUSSIONS

The results describe the intensity of traffic, time scale of packet transmission, Hurst index parameter . Primarily the transition rate of matrix Q and packets arrival rate in MAP are represented as Λ. S.K. Shao, Malla Reddy Perati (2005) gave MMPP design model in the form of generalized variance-based method for the self-similar traffic. It contains Hurst parameter H=0.7,0.8,0.9, values variance $\sigma^2 = 0.6,$ arrival rate $\lambda = 1$ with different time intervals $[10^2, 10^5], [10^2, 10^6],$ and $[10^2, 10^7]$. The stationary probability vector $\vec{y}$ is enumerated and then mean delay w is computed against traffic intensity without taking voids in [7, 22] using the formula $w = \bar{\nu} \sum_{k=1}^{\infty} k(\vec{y}_k\, e)$ to realize the effect of void consideration. From Fig.2, it is apparent that as traffic intensity increases, the mean delay increases. First, at $\rho = 0.4,$ the packet loss probability is computed [12], then $\bar{\nu}_e$ is computed using eqn (13), and then the mean delay is computed against D using eqn (15). Results are depicted in Fig. 3.

Fig.4 illustrates that mean delay automatically increases D and the values are higher when H and time scale are higher. Fig. 5 depicts the variation in mean delay against traffic intensity ρ , when the Delay Line Unit DLU (D)=0.1. From Fig. 4, one can infer that mean delay increases as ρ increases. From Figs.4 and 5, it is clear that the trend in the case of voids is different from the one without voids, and the values are higher in the case of voids..

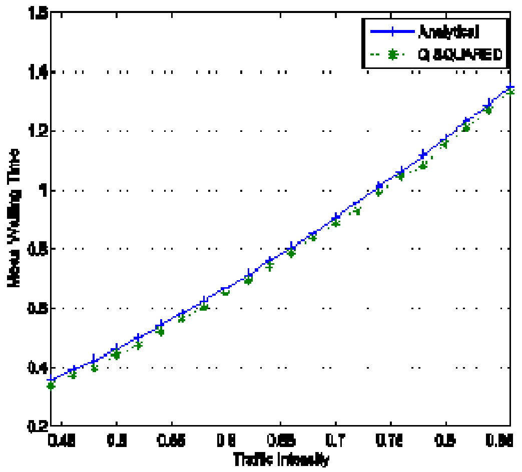

Figure 3: Mean Waiting Time with Traffic Intensity when H=0.7 and d=4.

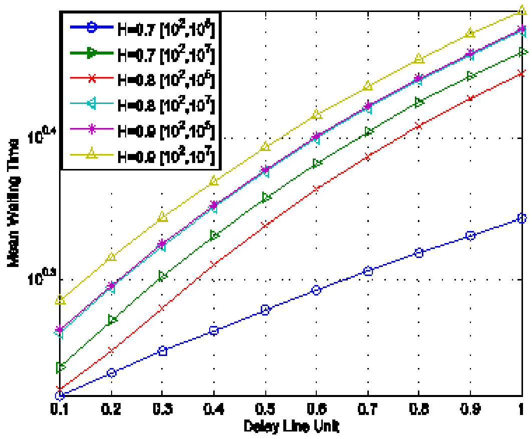

Figure 4: Variation in Mean Waiting Time with Delay Line Unit at different Γ .

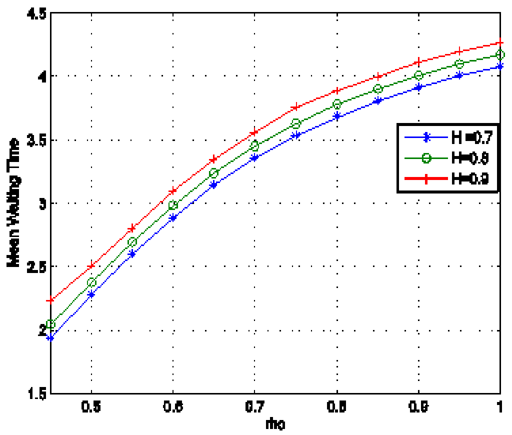

Figure 5: Variation in Mean Delay with Traffic Intensity at various Γ .

V. CONCLUSIONS

The switch/router contains uneven length packet input traffic, which can be modeled as self-similar $MMPP/M/1/k$ method, and we analyzed delay behavior of the switch. In this proposed paper of MMPP model, the variance in self-similar traffic over a time-scale has to be matched. In this model, packet lengths and voids are assumed to follow exponential distribution and rectangular distribution. Our numerical results reveal that time scale and Hurst parameters do have an impact on the mean delay. If the factors are Γ , ρ and DLU(D), the mean delay increases. Finally we understand that one could select the appropriate time interval D to approach the QoS obligation. This type of analysis is supportive evidences to switch/router. It is dimensioning not only the switch/router but also Hub and any network device. The results are based on the concept of self-similar variable length packet traffic. In future work to implement Markovian models in cloud computing, big data and internet of things [23] [24][25][26].

REFERENCES

[1] Vern Paxson, Sally Floyd, "Wide Area Traffic: The Failure of Poisson Modeling", IEEE/ACM Trans. Networking, 3, pp.226-244, 1995.

[2] W.E.Leland, M.S.Taqqu, W.Willinger and D.V. Wilson "On the Self-Similar Nature of Ethernet Traffic (Extended version) "IEEE / ACM Trans. Networking, 2, pp. 1-15, 1994.

[3] M. Crovella and A.Bestavros, "Self-Similarity in World Wide Web traffic: evidence and possible causes", IEEE/ ACM Trans. Networking, pp.835-846, 1997.

[4] T. Yoshihara, S.Kasahara, and Y. Takahashi, "Practical time-scale fitting of self-similar traffic with Markov-modulated Poisson process," Tele commun. Syst., vol.17, pp.185-211, 2001.

[5] S.K. Shao, Malla Reddy Perati, M.G. Tsai, H.W. Tsao and J. Wu, "Generalized variance-based Markovian fitting for self-similar traffic modeling," IEICE Trans. Commun., vol.E88-B, no.12, pp.4659-4663, April 2005

[6] L.P.Raj Kumar, K. Sampath Kumar, D.Mallikarjuna Reddy, Malla Reddy Perati, "Analytical Model for Performance Study of the Switch under Self-Similar Variable Length Packet Traffic" , Proceedings of The World Congress on Engineering and Computer Science-2010, WCECS 2010, San Francisco, USA, pp. 243- 247,. 20-22 October, 2010.

[7] L.P.Raj Kumar, K. Sampath Kumar, D.Mallikarjuna Reddy, Malla Reddy Perati, "Analytical Model for Loss and Delay Behavior of the Switch under Self-Similar Variable Length Packet Input Traffic", IAENG International Journal of Computer Science,38:1, IJCS_38_1_03, 10 February, 2011.

[8] F.Collegati, "Approximate Modeling of Optical Buffers for Variable Length Packets" Photonic Network Communications 3:4,383-390,2001.

[9] Allan T. Anderson, Bo Friis Nielsen , " A Markovian Approach for Modeling Packet Traffic with Long Range Dependence" IEEE Journal on Selected Areas in Communications, Vol.16, No.5, pp.719-732, June 1998.

[10] B.Venkataramani, Sanjay K. Bose, K.R. Srivathsan "Queuing analysis of a non-pre-emptive MMPP/D/1 priority system", Computer Communications, Vol. 20, pp.999-1018, 1997.

[11] Malla Reddy Perati, Chih-How Chang, Shou-Kuo Shao and Jingshown Wu, "An Efficient Approximate Markovian Model for Optical Packet Switches Employing Partial Buffer Sharing Mechanism under Self-Similar Traffic Input", Proceedings of IEEE HPSR-2007 held at Polytechnic University, Brooklyn , New York, USA, May 30-June1,ISBN:1-4244-1206-4, IEEE Catalog number: 07EX1775C.

[12] Shoji Kasahara, "Internet Traffic Modelling : Markovian Approach to Self-Similar Traffic and Prediction of Loss Probability for Finite Queues", Special Issue on Internet Technology, IEICE Trans. Commun., Vol. E84-B, No.8, pp.2134-2141, August 2001.

[13] C.Blondia, "The N/G/1 finite capacity queue" ,Commun. Stat. Stochastic Model, 5(2), pp.373-394, 1989.

[14] A.N.Dudin, V.L.Klimenok, and G.S.Tsarenko, "Software SIRIUS ++ for Performance Evaluation of Modern Communication Networks, Proc.ESM 2002, 16 th European Simulation Multiconference: Modelling and Simulation 2002, pp.489-493, Fachhochschule, Darmstadt, Germany, June 2002.

[15] Pushpalatha Sarla, D.Mallikarjuna Reddy, Manohar Dingari, "A Study on Self Similarity Analysis of Web Users Data at Selected Web Centers" Proceedings of International conference on Mathematics ICM- 2015.

[16] D.Mallikarjuna Reddy, Pushpalatha Sarla, Manohar Dingari, "Self Similarity Analysis of Web Users Arrival Pattern at Selected Web Centers". American Journal of Computational Mathematics, Vol.6 No.1, Mar 2016.

[17] Doodipala Mallikarjuna Reddy, Thandu Vamshi Krishna, B. Mallikarjuna Analytical Study of Internet Routers Under Self-Similar Network Traffic with Voids, Computing Communications and Data Engineering Series.

[18] D. Mallikarjuna Reddy, Pushpalatha Sarla, "Linear Regression Model Fitting and Implication to Self Similar Behavior Traffic Arrival Data Pattern at Web Centers" Volume 19, Issue 1, Ver. II (Jan.-Feb. 2017), PP 01-05 www.iosrjournals.org.

[19] Krishna P.V, Iyengar NCHSN, "Optimal Channel allocation alcation algorithm with efficient channel reservation for cellular networks". International Journal of Communication Networks and Distributed Systems, Published in Inderscience Vol. 1, Issue 1 (2008) , PP 33-51

[20] P. Venkata Krishna, N.Ch.S.N Iyengar "Sequencing technique: an enhancement to 802.11 medium access control to improve the performance of wirelss networks" Internaional Journal of Communication and Distributed Systems, Vol. 1, No. 1, 2008.

[21] Krishna P.V, Misra S, Oaidat MS, Saritha V " A new Scheme for Distributed Channel Allocation in Cellular Networks in Cellular Networks. In: Proc of the Spring simulation multiconference. San Dieg, California (March 22-27, 2009) doi: 10.1145/1639809.1639888.

[22] Ullah F, Babar MA. "Architectural Tactics for Big Data Cybersecurity Analytics Systems: A Review". Journal of Systems and Software. 2019 May 1;151:81-118.

[23] B.Mallikarjuna, Mhd. Shahjad, Anad Dohare, Tulika " Feed forward Approach for Data Processing in IoT over Cloud" International Journal of Innovative Technology and Exploring Engineering (IJITEE), Published By: Blue Eyes Intelligence Engineering & Sciences Publication Retrieval Number: BS1998128218 /19©BEIESP, ISSN: 2278-3079, Volume 8 Issue 5, March 2019, Pages 899-903.

[24] B.Mallikarjuna, Mhd. Shahjad, Anad Dohare, Tulika " Master Slave Scheduling Architecture for Data Processing on Internet of Things" International Journal of Innovative Technology and Exploring Engineering (IJITEE), Published By: Blue Eyes Intelligence Engineering & Sciences Publication Retrieval Number: BS1998128218 /19©BEIESP, ISSN: 2278-3079, Volume 8 Issue 5, March 2019, Pages 556-559.

[25] B.Mallikarjuna, P.Venkata Krishna "Nature Inspired Approach for Load Balancing of Tasks in Cloud Computing using Equal Time Allocation Policy" International Journal of Innovative Technology and Exploring Engineering (IJITEE), Published By: Blue Eyes Intelligence Engineering & Sciences Publication Retrieval Number: BS1998128218 /19©BEIESP, ISSN: 2278-3079, Volume 8 Issue 2S2, December 2018, Pages 46-50.

[26] B.Mallikarjuna, P.Venkata Krishna " Nature Inspired Bee Colony Optimization Model for Improving for Improving Load balancing in Cloud computing" International Journal of Innovative Technology and Exploring Engineering (IJITEE), Published By: Blue Eyes Intelligence Engineering & Sciences Publication Retrieval Number: BS1998128218 /19©BEIESP. ISSN: 2278-3079, Volume 8 Issue 2S2, December 2018, Pages 51-55.