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Performance analysis of mixed poling schemes with multiple classes of traffic input

Mohsin Iftikhar, Muhammad Imran and Ijaz Ali Shoukat

Abstract—**Solitary polling technique is not a better choice to get rid of multiple queuing problems for getting enhanced performance against single server. Enhanced and reliable performance upon multi queued traffic can be achieved through the utilization of right selection of joint polling schemes. The complexity of polling design is directly proportional to its performance. Exhaustive polling scheme is outperformed by limited service polling policy but under average load of traffic both contain same mean transfer delay. Several polling methods are the part of literature but the question of their optimal utilization in joint manners against multiple queue buffers is still open. In this paper, we experimentally implement four queues polling model with different arrangements of polling services to conclude the best optimal and joint polling method through analyzing the co-relation between delay and Hurst parameter. We further investigate; which individual performance metric affects the other performance parameters in queuing networks and as a result the overall performance is degraded.**

Keywords— **Polling Models, QoS, Queuing Techniques, Exhaustive, Gated, Limited Service**

I. Introduction

Polling Model is a multi-queue access management system that embodies several queues to a solitary server in optimal ways. More often polling techniques can accurately be analyzed if branching property is truly satisfied which means each job in queue should always follow a unique (random) identifier during each server‘s call as reported in study [1]. To achieve effectual and reliable performance in the presence of divergent load and congestion, an appropriate selection of right polling scheme is necessary. Queue demonstration can be distinguished under three different polling routines [2]: (1) Exhaustive Method –in which a system (server) cannot leave the queue until it becomes vacant, (2) Gate Method - on each queue visit, the server serves only those number of packets from that queue which are present at the polling instant, (3) Limited Service Method –the server serves specific number of packets from each queue during each cycle. The polling model under exhaustive scheme[3]has been represented in Fig. 1.

Mohsin Iftikhar, Hassan Mathkour, Muhammad Imran and Ijaz Ali Shoukat
College of Computer and Information Sciences, King Saud University
Riyadh, Saudi Arabia

Finite set of queues can be represented to single server in cyclic order with non-zero switching time through polling model [4] and its potential usages lie under transposition, telecommunication, reliability management of computer networks, manufacturing and health caring infrastructures etc. Recently, polling system has been actively implemented in resource sharing of wireless channels through Media Access Protocol (MAC) [5, 6]. Furthermore, polling model is actively being used in IEEE 802.11 cellular local area networks [7, 8], broadband cellular channels [9] and “Ethernet Passive Optical system” [10] because polling system is reliable under peak load as compared to other connection oriented protocols [11].

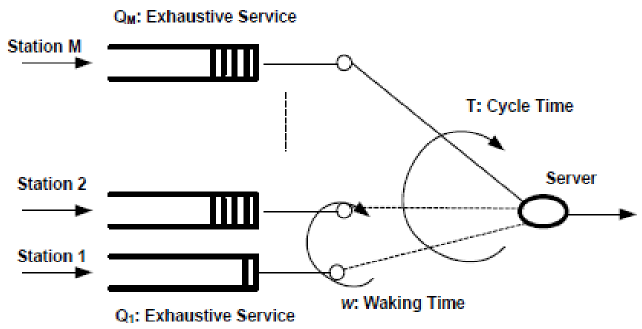

Figure 1: Exhaustive Polling Scheme

In this paper we experimentally implemented the mixture of polling policies with different set of arrangements to conclude which polling mixture provides reliable results in the presence of asymmetric classes of traffic being fed to four different queues. We experimentally analyzed the co-relation between delay and Hurst Parameter on the basis of different combination of traditional polling schemes. The main objective of this work is to point out which combination of joint polling schemes provide guaranteed QoS to multiple classes of network traffic in today’s multiservice internet.

II. Literature Review

Queuing methods facilitate the way to handle multidisciplinary traffic under the utilization of buffering technology. A lot of queuing techniques like Low Latency Queuing (LLQ), Priority Queuing(PQ), Class based Weighted Fair Queuing (CBWFQ) and Custom Queuing (CQ) have been introduced in last decades[14]. But the multimedia traffic carried in modern fixed and wireless networks exhibit self-similar characteristics [15, 16].Therefore, it is important to consider the bursty nature of traffic while conducting the analysis of any kind of queueing system. Further, in this study we also aim to investigate,

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which performance metric is responsible for degrading the efficiency of other performance metrics.
In our prior work, we have d out that how load and congestion affects the performance of remote services [24].The mutual relationship between hop counts and congestion has also been found in [24].

The authors in [2] implemented different queuing logic against an individual server. The authors have considered two different scenarios. Case 1: if queue is empty upon a visit then it will not be visited upon upcoming visit and Case 2: with limited service polling policy they have investigated the stable and unstable condition of different queuing schemes. For the analysis of polling models, a framework has been designed by the authors of study [1]. Their main contribution is that; the presented framework is able to manage those jobs that did not meet branching property.

The exhaustive and gated policies are dependent on the priority of each job that bounds the server execution to follow the indicated preference of job. On the other side, k-Limited polling strategy is preferred rather to these policies (gated, exhaustive) due its facility of defining the job execution limits [1]. Recently Time Autonomous-Server polling strategy similar to K (time)- Limited polling model that control the server to reside at queue for specific time even in the condition of empty queue has been discussed in studies [12, 13].The performance of polling model is highly affected under the following factors as reported in study [1].

1. Complexity of Polling Scheme that causes more load
2. Increment in cycle time with the linear addition of more queues
3. Increments in cycle time under overloaded situation

Many studies related to polling models have been conducted in recent years. The analysis of exhaustive and gated polling schemes has been conducted in [17] by considering the switch over time equivalent to zero. The analysis of exhaustive polling method with arbitrary number of queues has been reported in [18]. The authors in [19] have analyzed two queues in which one queue is being served by exhaustive service and other one though limited service policy. We further refer the readers to [20-22] to have an overview of the related work being conducted in the area of polling models.

The outperformed polling design can be achieved through average transferring rate with small queue buffer and lesser possible server walk through time upon each queue. Larger visiting time and number of nodes result higher cycle time and as a result waiting time is increased that diversely affects the performance of any queuing model. Exhaustive polling strategy seems to be more efficient as compared to limited service polling policy but under average load of traffic. On the other hand both exhibit same performance in terms on mean delay transfer [3]. The interesting finding is that, in case of overload condition, the limited service polling technique is better in terms of lower delay but this performance is directly correlates the value of k, because in case of higher value of k it almost performs similar to exhaustive technique as reported by the authors of study [3]. Therefore, in this study our motive is to analyze different combinations of polling strategies (Table 1). The ultimate objective is to find out different kinds of suitable polling combinations for different kinds of networks according to the requirement of applications found in those networks.

III. Methodology

We adopted experimental way to get the simulation results by using the discrete event simulator developed in C++ with different modern set of logics. The developed discrete event simulator is quite modular in design that provides the facility to implement different kinds of scheduling logic under multi-disciplinary traffic input. In this study our logic revolves around five different set of polling strategies as summarized in Table 1 below.

TABLE 1: COMBINATIONS OF DIFFERENT POLLING SCHEMES

Mixed Polling Schemes	**Queue 1**	**Queue 2**	**Queue 3**	**Queue 4**
Gated and Exhaustive service Policy	Exhaustive	Exhaustive	Gated	Gated
Gated and Exhaustive service Policy	Exhaustive	Exhaustive	Exhausti ve	Gated
Gated and Limited service Policy	Limited Service	Limited Service	Gated	Gated

The developed discrete event simulator implements a special Scheduler class, where the design template has been used as discussed in [23]. A traffic generator was also written, which implements the bursty (self-similar) traffic input. This generator may also be over-ridden by another traffic model. A number of other associated classes like Simulation, Random Number and Packet, were also written to facilitate program function and accuracy. This section presents a comparison of simulation results of two different kinds of scheduling schemes. In both cases, the capacity of each queue is 10 packets. The following values have been presented for the class 1 traffic: the session arrival rate is adjusted to $\lambda_1 = 6 s^{-1}$, the in-session packet arrival rate is $\alpha_1 = 50\ s^{-1}$ (the property of VoIP traffic) and the service rate to $\mu_1 = 2500\ s^{-1}$. Also, the following values have been selected for queue 2, 3 4: the session arrival rate= $\lambda_2 = \lambda_3 = \lambda_4 = 50\ s^{-1}$, the in-session packet arrival rate= $\alpha_2 = \alpha_3 = \alpha_4 = 6 s^{-1}$ and the service rate $\mu_2 = \mu_3 = \mu_4 = \mu_1$.

IV. Simulation Results

In this section, we present the simulation results for different kinds of polling combinations.

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A. *Simulation Results of Mixed Exhaustive and Gated Service Policy Queue 1 (Exhaustive), Queue 2 (Exhaustive), Queue 3 (Gated), Queue 4 (Gated)*

This section presents the simulation results for 4 queues model with mixed Gated and Exhaustive service policy. The scheduler serves queue 1 and queue 2 in exhaustive manner, whereas it serves queue 3 and 4 according to the gated service policy. The effect of varying the Hurst parameter (0.5<H<1) on mean queuing delay has been studied as shown in Figure 2 below.

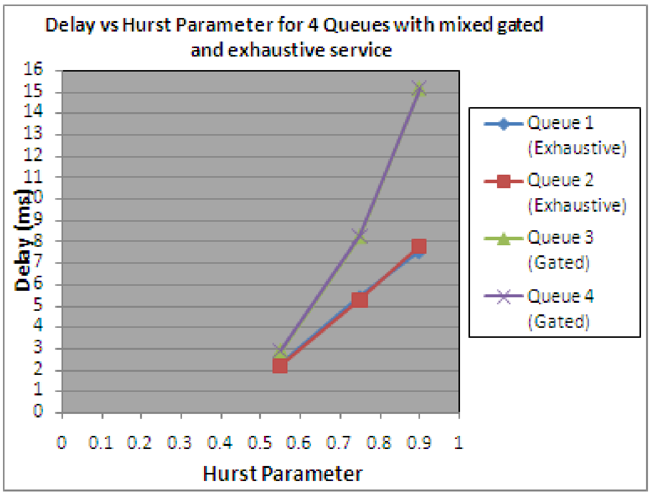

Figure 2: Mean Delay and Hurst parameter: 4 queues Mixed Gated an Exhaustive (Queue 1and Queue 2: Exhaustive service, Queue 3 and Queue 4: Gated service).

Figure 2 shows the mean delay versus Hurst parameter for four queues model with mixed Gated and Exhaustive service. We can observe in both cases, i.e. exhaustive and gated, as soon as Hurst parameter increases, the mean delay also increases. But in this system, the queue 1 and queue 2, which have been served according to the exhaustive manner have lower mean delay as compared to other queues (queue 3 and 4) that are being served according to the gated policy.

B. *Simulation Results of Mixed Exhaustive and Gated Service Policy Queue 1 (Exhaustive), Queue 2 (Exhaustive), Queue 3 (Exhaustive), Queue 4 (Gated)*

This section presents the simulation results for 4 queues model with mixed Gated and Exhaustive service policy. The scheduler serves queue 1, queue 2 and queue 3 in exhaustive manner, whereas it serves queue 4 according to the gated service policy. The effect of varying the Hurst parameter (0.5<H<1) on mean delay has been studied as show in Fig. 3 below.

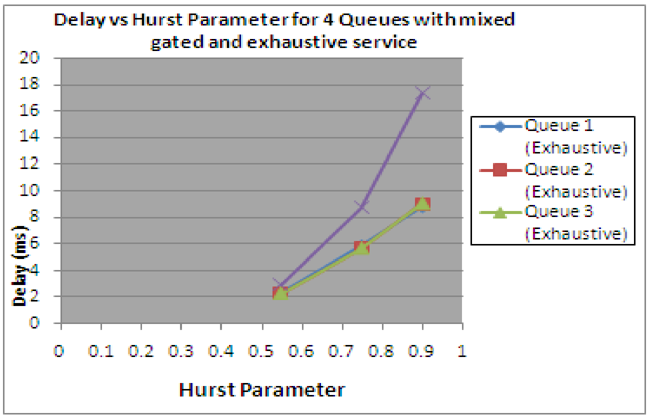

Figure 3: Mean Delay vs. Hurst Parameter: Simulation Results for 4 queues Mixed Gated and Exhaustive (queue 1, queue 2 and queue 3: Exhaustive service, queue 4: Gated service).

Fig.3 shows the mean delay versus Hurst parameter for four queues model with mixed Gated and Exhaustive service. We can notice that in both cases, i.e. exhaustive and gated, as soon as Hurst parameter increases, the mean delay also increases. But in this system, the queue 1, queue 2 and queue 3, which have been served according to the exhaustive manner, have lower mean delay as compared to queue 4 being served according to the gated policy.

C. *Simulation Results of Mixed Gated and Limited Service Policy Queue 1 (limited service), Queue 2 (limited service), Queue 3 (Gated), Queue 4 (Gated)*

This section presents the simulation results for 4 queues with mixed gated and limited service logic. The scheduler serves 4 packets from queue 1 and 2 packets from queue 2 during each cycle, whereas it serves queue 3 and 4 according to gated service. The effect of varying the Hurst parameter (0.5<H<1) on mean delay has been studied. Fig. 4 shows the mean delay versus Hurst Parameter for four queues with mixed gated and limited service policy.

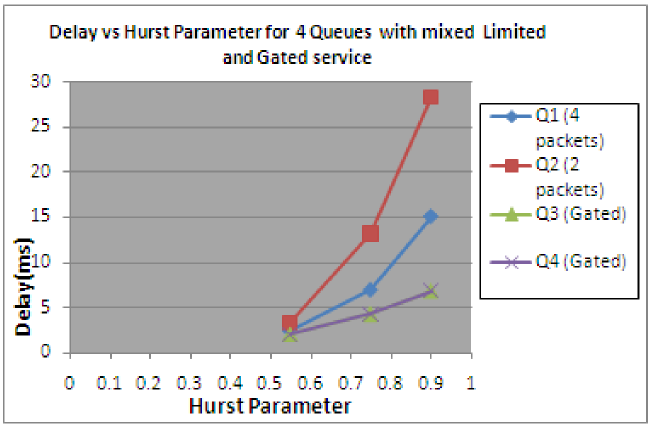

Figure 4: Mean Delay vs. Hurst Parameter: Simulation Results for 4-Queues with mixed gated and limited service(Queue 1 and 2: Limited service, Queue 3 and 4: Gated)

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Thorough experimentation three models have been tested against mean delay and Hurst parameter. Consequently, to filter queues through joint effort of limited and exhaustive schemes is efficient as compared to the triple combination of limited, exhaustive and gated methods.

V. Conclusion

In this paper, we have analyzed different combinations of traditional polling schemes. The joint scheme (Limited + Exhaustive) gives better performance as compared to (Limited+ Exhaustive + Gated) polling model. We have also noticed that when limited service policy is combined with gated method, its performance remained almost equivalent to (Limited+ Exhaustive + Gated) polling method. Similarly, the combination of (Gated + Exhaustive) gives better performance results as compared to (Limited + Exhaustive) method with the approximated difference. Hence, as an individual polling method, the limited polling scheme is good but exhaustive method is more efficient as compared to all others. Finally, as many queues will be pulled exhaustively, it will be a good decision. Through our analysis we also have predicted that, delay is the key factor in joint polling schemes because the increment in delay factor caused the following issues:-

1. Request time out that further causes more waiting time
2. Large waiting time results more buffer size that causes large queue
3. Large waiting packets get resulted in loaded situation
4. Extra load results congestion upon the router(s).
5. Due to congestion the packet starts dropping
6. Over all these situations degrades the throughput, reliability and availability of services.

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