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SURVEY ON LOAD BASED AQM ALGORITHMS

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ABSTRACT

Internet faces the problem of congestion due to its increased use. AQM is a technique that consists of ECN in internet routers. AQM algorithm is an solution to the problem of congestion control in the internet. There are various existing algorithm that have evolved over the past few years to solve the problem of congestion in IP networks. This paper discus the various Load based algorithm in AQM.

Keywords- Internet, Queue, Congestion, Load, Routing

INTRODUCTION

Congestion in Internet occurs when the link bandwidth exceeds the capacity of available routers. This results in long delay in data delivery and wasting of resources due to lost or dropped packets. The increased use of multimedia applications also results in busty flows in the internet. So there is a requirement of regulation busty flows in the very large network in the internet. To regulate these busty flows, resource allocation must be done efficiently. It is known from routing algorithm focus on two main concepts namely Queue Management and Scheduling.

Queue Management in router plays an important role in taking care of congestion. Two approaches are adopted to solve this problem. First one is Congestion avoidance preventive technique, which comes into play before network is congested by overloading. Second is Congestion Control, which comes into play after congestion at a network has occurred and the network is overhead.

A Congestion Avoidance scheme is proactive one that maintains the network is a state of low delay and high throughput by keeping the average queue size low to accommodate busty

traffic transient congestion. It makes TCP responsive to congestion, as TCP will back off its transmission rate when it detects packet loss. A congestion control scheme is a reactive scheme that reacts after the congestion occurs. To remove such problems, widely AQM algorithm is used.

ACTIVE QUEUE MANAGEMENT

The essence of Internet congestion control is that a sender adjusts its transmission rate according to the congestion measure of the networks. There are two approaches to accomplish this. One is a sourced algorithm that dynamically adjusts the transmission rate in responsive to the congestion along its path; the other one is a link algorithm that implicitly conveys information about the current congestion measure of the network to sources using that link. In the current internet, the source algorithm is carried out by AQM scheme at routers.

LOAD BASED AQM

Load based AQMs determine congestion and take actions based on packet arrival rate. The goals of the load based AQMs are to alleviate rate mismatch between enqueue and dequeue, and achieve low loss, low delay and high link utilization. The load information [5] is such schemes are measured in various forms, such as the queue length slope, or the difference between input rate and output rate. A simple load indicator that we will use is the load factor defined as the ratio of periodically measured arrival rate (Input) and service rate (Output).

Load_Factor = Input_Rate / Output_Rate

It contains three parts. First one is Congestion with flow information. Second one is congestion metric without flow information. Last one is only flow information. Congestion metric without flow information supported to the Queue based, Load based, Both Queue & Load based, and other types. But congestion with flow information not supported to the Both Queue & Load based flows.

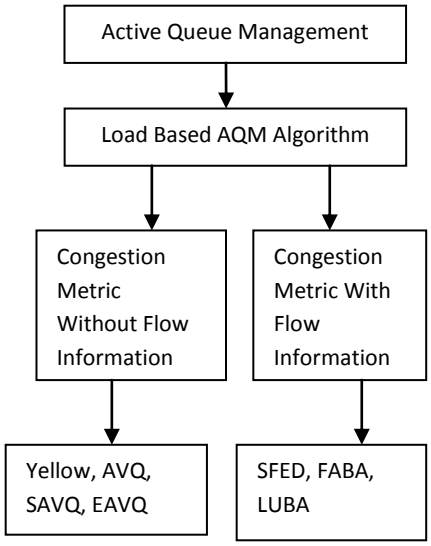

Fig.1.Classification of AQM Schemes

Congestion metric without flow information

It is the first category of classification that considers only the congestion metric and not the flow information. The following are the Load based algorithms in AQMs.

A) *YELLOW:* A new rate based active queue management (AQM) algorithm, called Yellow. Yellow [6] Active Queue Management Algorithm uses mismatch between the input rate and link capacity as the primary metric. Therefore the advantages of load based AQMs are inherited. Furthermore, queue size is made as a secondary metric. Queue length affects the load factor using Queue Control Function (QCF), which is computed by a non-linear hyperbola function of instantaneous queue length and reference queue size. Known form other load bases schemes Yellow provides an early controlling queuing delay maintaining the main load merit. The average queue length and standard deviation of queue length of Yellow are little affected by the introduction of the UDP flows.

B) *Stabilized Adaptive Virtual Queue (SAVQ):*It is observed that the desired utilization parameters in AVQ algorithm use influence on the dynamics of queue and link utilization. [7] It is difficult to receive the faster system response. An adaptive setting method for Υ is proposed according to the instantaneous queue size and the given reference

queue value is Stabilized Adaptive Virtual Queue Management algorithm (SAVQ) [7] which stabilizes the dynamics of queue maintaining a high link utilization. The table shows the performance indices of AVQ and SAVQ.

Table 1. Performances of AVQ and SAVQ (Reprinted from Ref., [7])

	AVQ		SAVQ
Criterion	**ϒ=1.0**	**ϒ=0.98**	
Average Queue Length	115.4	37.64	43.19
STD of Average Queue Length	72.52	52.53	38.09
Utilizations %	99.86	98.22	99.58
Loss Ratio %	0.339	0.129	0.092

C) *Adaptive Virtual Queue (AVQ):* Adaptive load based AQM called Adaptive Virtual algorithm for Active Queue Management (AVQ) [8] which maintains a virtual queue whose capacity is less than the actual capacity of the link. Hence a packet arrives in a real queue, virtual queue is also updated to reflect the new arrival. Packets in the real queue are dropped/marked when the virtual buffer overflows. The virtual capacity at each link is then adapted to ensure that the total flow entering each link achieves desired utilization of the link. There are two parameters that have been chosen to implement AVQ one is the desired utilization ϒ and the other is damping factor α.

Pseudo code of AVQ algorithm

```
At each packet arrival epoch do
VQ = max (VQ – Ĉ(t – s),0) /*Update Virtual Queue Size*/
If VQ + b > B
Mark or drop packet in the real queue
Else
VQ = VQ + b /*Update Virtual Queue Size*/
End if
Ĉ = max(min(Ĉ + α * ϒ * C * (t – s),C) – α*b,0)
S = t
 Constant
C = Capacity of a link
B = buffer size
b = number of bytes in current packet
α = smoothing parameter
ϒ= desired utilization of the link
Other
Ĉ = Virtual queue capacity
t = Current time
s = arrival time of previous packet
VQ = Number of bytes currently in the virtual queue
```

D) *Stable Enhanced Adaptive Virtual Queue (EAVQ):* An enhanced to AVQ was proposed in (rate) load based Stable Enhancement Adaptive Virtual Queue (EAVQ) algorithm [9]. The concepts of the principal and subordinate measures of congestion, as well as desired link utilization ratio were introduced into EAVQ. Arrival rate at the network link was maintained as a principal measure of congestion. The desired link utilization ratio was used as a subroutine measure and a rate-based adaptive mechanism of which was designed to resolve the problems, such as hardness of parameters setting, poor ability of anti-disturbances, and a little link capacity loss. EAVQ improved the transient performances of the system and ensured the utilization of link capacity. EAVQ give the excellent performance of higher utilization, the lower link loss rate, the more stable queue length, and the faster system dynamic response than AVQ.

Congestion Metric with flow information

It is the first category of classification that considers the congestion metric and the flow information. The following are the Load based algorithms in AQMs.

A) *SFED:* SFED [10] is an easy to implement rate control based AQMs discipline, which can be coupled with any scheduling discipline. It operates by maintaining a token bucket for every flow (or aggregates of flow). The tokens filling rate are in proportion to the permitted bandwidths. Whenever packets are enqueue, tokens are removed from the corresponding bucket. The decision to enqueue or drop a packet of any flow depends on the occupancy of its bucket at the time. A sending rate higher than the permitted bandwidth results in low bucket occupancy and so a larger drop probability inform to the gateway. But this flow does not stop the sending rate even more loss. When the time flow is equal to the rate of incoming packets the rate tokens removed from bucket. The rate is fully depends on its bandwidth not on the packets flow.

B) *Fair Adaptive Bandwidth Allocation (FABA):* The extension makes FABA algorithm scalable, practical to implement as compared to the SFED algorithm. The FABA [11] algorithm is use very large number of HTTP connections and FTP and Telnet connections also, FABA performs consistently better

than any other AQM mechanisms. It is uses the both fragile and non-fragile sources. When the traffic mix of these sources FABA provides the bandwidth allocation for fragile flow almost good in ideal case. It offers congestion avoidance by early detection and notification with low implementation complexity. It performs better than RED and CHOKe. In case of buffer sizes constrained, it performs significantly better than FRED.

C) *Link Utilization Based Approach (LUBA):* LUBA stands for Link Utilization Based Approach [12]. In this approach, the malicious flows are identifies which might be causing congestion at the router and assign them drop rates in proportion of their abuse of the network. If the overhead factor $U=\lambda/\mu$ (where λ is the aggregate arrival rate of the router, μ is the outgoing link capacity of the router), is below the target link utilization, the router is non-congested and packets are not marked or dropped. When it is greater, all arriving packets are monitored while assigning –id flow of the router. The packets is inserted in FIFO queue not for the dropping probability. If the packet does not get dropped, it is inserted into the FIFO buffer.

It offers high throughput and avoids global synchronization of responsive flows. LUBA works well in different network conditions and the complexity the algorithm.

Table.2 Comparison of AQM schemes based on Classification (Reprinted from Ref., [3])

AQM Schemes	Queue occupation		
	Max. the Queue	Min the Queue	Keeping Queue around a target
YELLOW	×	×	√
AVQ	×	×	√
FABA	×	×	√

Table.3 Comparison of AQM schemes based on Classification (Reprinted from Ref., [3])

AQM Schemes	Adaptive	Non-Adaptive		
		Robust	Fragile	Non Responsive
YELLOW	√	√	√	√
AVQ	√	×	×	×
FABA	√	√	√	√

Table.4 Advantages & Disadvantages of AQM Schemes

AQM Schemes	Advantages	Disadvantages
Congestion Metric Without Flow Information		
YELLOW	It has an high congestion control performance and Queue Control Function (QCF).	Parameter settings have large amounts of principles.
AVQ	High link utilization. Fixed & DT type of Virtual Queue (VQ).	It do not have malicious awareness
SAVQ	Loss rate is low and reduce fairness problem.	It is difficult to receive the system response. It is Maximum used constant values
EAVQ	Higher utilization of link capacity. Dynamical response then AVQ	Hardness of parameters settings. Poor ability of anti-disturbance and link capacity.
Congestion Metric With Flow Information		
SFED	It maintains the token bucket for every flow. Token bucket keep record of the corresponding flows.	It had any scheduling discipline.
FABA	Very high link utilization and high Throughput. It have low loss rate. It is a scalable algorithm.	Very high complexity, computation.
LUBA	It have High throughput. Avoid global synchronization of responsive flows.	It does not handle unresponsive flows.

CONCLUSION

In this paper, the queue based AQMs algorithms are analyzed based on congestion metrics and the flow information. This paper provides a survey about the Queue length based AQM Algorithms. They all have a common aim that is to achieve Congestion avoidance. A new AQM Algorithm can be proposed to overcome all the problems in the existing ones.

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