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An Approach to Analyze Quality of Service

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Abstract: ***In this paper, we review the basic of Quality of Service. The key idea is to decouple congestion measure from performance measures such as loss, queue length or delay. The resources that network needs to manage are buffer and bandwidth. Specifically, paper starts by introducing the services in QoS, buffer management scheme and scheduling. Scheduling mainly used to distinguish between the packets that selected by the scheduler for further processing. Its main goal is to improve the QoS. Buffer management used to control traffic fairly and efficiently. Also, includes two QoS framework. Integrated services (intserv) and differentiated services (diffserv). IntServ uses RSVP to reserve resources whereas DiffServ controls network traffic. Congestion in network occurs due to exceed in demand as compared to the capacity of the resources. At the end, an effort has been made to judge the performance of Drop Tail and RED. The RED introduces randomness to overcome the problem of global synchronization.***

KEYWORDS: **QoS, IntServ, DiffServ, Queue Management, RED, Drop Tail, RSVP.**

I. INTRODUCTION

Quality of service [1, 2] has been one of the emerging research areas in computer networks. Quality of service (QoS) is the overall performance of the network seen by the users. QoS can be achieved by managing the flow characteristics such as reliability, delay, Jitter and bandwidth. It is necessary for the system, that it must be reliable so that a proper acknowledgement is received and no packets are lost in transit. QoS is mainly used to manage the network resources. The paper is written as follows, firstly going to cover the importance of adding QoS in internet, including scheduling and trying to cover merits and demerits and a brief introduction of buffer management. After that, two service architectures namely Diffserv and Intserv. Lastly, we presented the queue management including two schemes mainly Drop Tail and RED.

II. MOTIVATION

We have to fight through the bad services in order to earn the best one because the important one finds the way rather than excuses. In quality of service there two are major axes to provide the different levels of services in the network are control path and data path [2].It is the responsibility of data path mechanism to classify and map the packets that are coming from the user, according to the required service class and also have the responsibility to control the consumption of resources by each service class. Data path mechanism is the basic building block on which QoS is built. Whereas, the control path mechanism includes admission control and policy control.

The resources that network need to manage are buffers and bandwidth, so for this we need a good buffer management schemes and scheduling algorithms. In this paper we are not going to explore all the scheduling and buffer management schemes, but we discuss only some of them. It is necessary to employ a good scheduling technique because it directly affects the QoS. Scheduling techniques is used to classify between the packets that are ready to transmit. Good scheduling techniques treat the packets coming from different flows in a fair manner. Many scheduling techniques are designed to improve the quality of service. We discuss some of them here: “FCFS” (first come first serve) is simplest algorithm, it serve packets in the order they arrive. But it have some problem, when the queue became full it also drops higher priority packets. So, the other algorithm came into existence is “Priority Queuing” (PQ). In PQ, each packet has some priority and packets are serviced on the basis of their priority. If no more packets in higher priority queue, then lower one is served. But the problem is that the lower priorities packets may get starve. So, it is not a fair algorithm because higher priority packets always served first and not give chance to lower ones. In contrast, “Fair Queuing”, in this technique queues are served in round robin fashion, one packet from first queue, one from second and so on, due to this higher priority flows may suffer it may have to wait for long period of time, so another algorithm called “WRR” (weighted round robin), it is the combination of priority queuing and fair queuing. It is the simplest approximation of GPS (generalized processor sharing) [7]. Generalized processor sharing it is also related to the fair queuing ,it classify the packets into groups and share the service capacity between them sharing based on the fixed weights. GPS is independent to packet sizes, since it assumes a fluid model. Instead of scheduling based on weights, an EDF scheduler comes, it is a form of dynamic priority scheduling. It assigns a “deadlines” to each packet that arrives at the scheduler and serves them in the ascending order of their deadlines.

If there is no buffer to hold the packets, the scheduling mechanism doesn't able to play their role, it is only effective if a good buffer management [2] scheme is also used. When congestion occurs, buffer management scheme has the ability to control traffic fairly and efficiently. The good buffer management scheme trying to avoid the loss of “high priority” packets, this is only happening when the queue is filled with many low priority packets. To overcome this problem we allow the higher priority packets to “push out” [9] the packets that have the lower priority, but its implementation is not easier. There are many buffer management schemes, but we cover two of them namely DROP TAIL and RED. Random early discard, in this scheme packets are discarded before the queue become full.

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RED uses feedback to inform the sources about the congestion, due to this they can able reduce their rate of sending packets. The second one is DROP TAIL, it simply drop packets when buffer is full. The detail of both schemes is covered in coming sections. The good buffer management scheme can avoid dropping those packets that fulfils the service contract.

III. SERVICES IN QOS

QoS have two architecture differentiated service (diffServ) and Integrated service (IntServ).

A. IntServ

Integrated service [8, 11, 12] was first developed by IETF in the late 1990's as the first time to provide quality of service (QoS) guarantees for some network traffics. The main goal of Intserv is that computer programmers want to reserve some portion of network for traffics like audio or video conferencing, real time voice etc require low delay, low jitter and guaranteed bandwidth. IntServ uses Resource Reservation Protocol (RSVP) [5, 11] to explicitly signal the QoS needs. Resource reservation protocol is a transport layer protocol used to reserve resources. It is a system designed for multicasting (one source to multiple receivers).

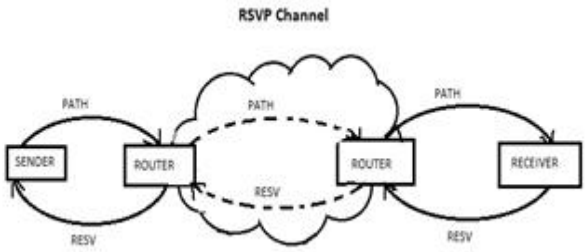

Fig.1: RSVP Signalling [1]

In RSVP, the receivers make the reservation, that's why it is also called receiver-initiated reservation style. In RSVP [1], we discusses about two main messages PATH (packet moves from sender to receiver) and RESV (packets moves from receiver to sender) (Fig.1). Initially, the PATH message propagates from the sender towards the receivers in the multicast path. Each router along the way record path information like bandwidth and other available network resources etc. when receiver, received a PATH message, it sends RESV message towards the sender to request resources in the path recorded by the PATH message. It depends on routers that they grant or reject the request made by RESV message. If intermediate routers support RSVP, then reservation is made and the network resources are allocated to the flow. Otherwise router decides the route for packets based on best-effort delivery. Resource reservation protocol (RSVP) uses *soft-state* approach, in this approach the flow-specific reservation information must be refreshed by the sender at regular interval (approx 30 sec). Due to this approach the connection setup complexity is reduces and improves robustness. But it has one problem; IntServ only works on a small-scale.

B. DiffServ

Differentiated services (DS) [1, 11] is architecture used to control the network traffic by class so that some special types of traffic get precedence over the other kinds. DiffServ provide a way to control the traffic is more flexible and more scalable. DiffServ is a coarse-grained class-based service in this we uses the concept of packet tagging [14]. Packet tagging is used to mark the packet by using bit in packet header, so that it can receive some preferential treatment. DiffServ is divided into several classes called per-hop-behaviour (PHB). To select the per-hop behaviour a packet experiences at each hop. DiffServ uses 6 bit DSCP (Differentiated Service Code Point) in 8 bit DS field in the IP header for packet classification. The proper treatment for packets in DiffServ domain can be decided only by looking at DSCP.

DiffServ traffic conditioning block (TCB) [10] - Traffic conditioning is located in the DS *ingress* or *egress* boundary nodes, sometimes it may also be located at interior nodes. Ingress node of the source domain is the first to mark packets, and egress node that leads as another DS domain may re-mark packets if required. Traffic conditioner is an entity that marks, meters drops and shapes traffic.

Classifier- Selects the packet in traffic stream and determine which flow or class it belongs based on the packet header.

- *Meter* - Measures the rate of traffic streams chosen by the classifier,
- *Marker* – Marker marks the certain fields in packet for differential treatment later.
- *Shaper* – It is used to delay some or all packets in the stream so that the stream matches the traffic profile.
- *Dropper* – Dropper is similar to shaper if we set the shaper buffer size to zero packets. It simply drops the packet that doesn't match the profile.

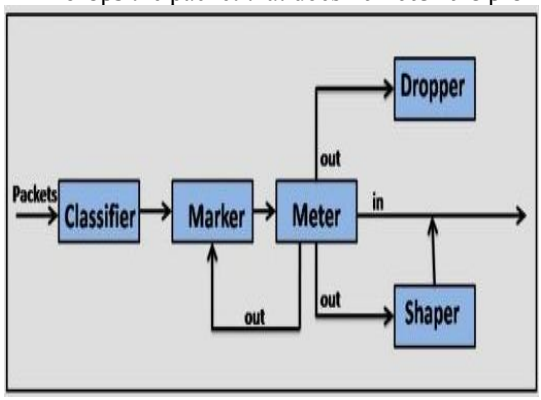

Fig.2: DiffServ traffic conditioning block
[http://ids.nic.in/jces%20tnl%20oct%202008/Q%20of%20S/Q%20of%20S.htm]

C. Comparison between Integrated services and Differentiated service

INTSERV	DIFFSERV
IntServ is per-flow based service.	DiffServ is per-class based service.
It delivers fine grained QoS guarantees.	It delivers coarse grained.

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IntServ are stateful (routers must remember the state information)	DiffServ are stateless (reduces the complexity or remembering the state information)
It is a bandwidth reservation technique, if bandwidth is reserved once, it cannot be reassigned to other traffics.	In diffServ there is no need to reserve the bandwidth.
It needs to refresh the state information periodically due to complexity at each node is increases.	It doesn't store information at nodes so refreshing is also not required.

IV. QUEUE MANAGEMENT

Queue management [1] is used to control and optimize queues. In internet, when several flow coming at single link it become bottleneck. When input rate exceeds the capacity of the link, congestion occurs. Queue management is a method to control congestion and if a queue is completely full, no other packets can be further get into the queue and will be dropped. Our goal is to control packet loss and achieve high throughput and low delay. In network, the buffer space is designed to handle only short term data bursts, not continuous bursty flow of data. So, by limiting the size of queue we can reduce packet delay bound. Queue management can be broadly divided into schemes, the mechanism that routers used to drop packets, when queue reaches to its maximum occupancy without taking any decisions, is Drop tail and the another scheme RED, it drops packets but on the basis of several decisions. So now, we focus on these two schemes.

A. Drop Tail

It is a simple queue management scheme. In this scheme, when the queue is full, the router starts discarding the new packets, thus means dropping the tail (the group of packets that are at end). Drop tail provides better link utilization because it uses FIFO based queue and also it is easier to implement due its simple nature. But it has some serious drawbacks namely lock-out and full queue phenomena. The "lock-out" problem arises when a single source or few sources monopolizes the available bandwidth. Another problem of "full queue", as the name signifies when the queue becomes full for a long duration of time, due to this large end-to-end delay arises. Bursty traffic suffers more losses in drop tail. So we need scheme like RED, it drops packets early so not to allow the queue to become full. The drop function for drop tail is shown in fig.3; fig.4 is taken from [13]

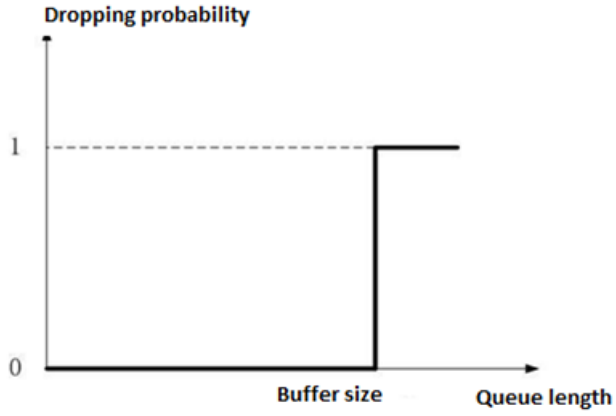

Fig.3: Drop function of Drop Tail

B. RED (Random Early Detection)

RED [4, 1] addresses some of the problem associated with drop tail it overcomes the problem of global synchronization (lock-out) of TCP by introducing randomness. RED algorithm was first time introduced by Sally Floyd and Van Jacobson [4]. The main goal of RED is to detect the congestion by observing the queue's average length. The RED congestion control mechanism monitors the average queue size, and when the average queue size exceeds the defined threshold, and then it start discarding the packets. In RED, firstly average queue length (size) is computed by low pass filter with exponential weighted moving average. Next, before the queue reached to its maximum occupancy, RED starts dropping packets probabilistically, this dropping mechanism is based on average queue length. It uses two types of thresholds namely maximum threshold (maxth) and minimum threshold (minth). In normal mode, no packets are dropped, if the average queue length is below the minimum threshold. But each arriving packets are marked, if the average queue length is above the maximum threshold, is the situation when congestion occurs. If the average queue length is between the minth and maxth then packets is marked with a probability pa[1]. This phase is called congestion avoidance phase.

Formulae for calculating average queue length [4]-

$$\mathbf{avg = (1-w)* avg + w*q} \quad \mathbf{(1)}$$

The initial packet marking probability [4]-

$$\mathbf{p_b <- max_p (avg - min_{th}) / (max_{th} - min_{th})} \quad \mathbf{(2)}$$

The final packet marking probability [4]-

$$\mathbf{p_a <- p_b / (1- count * p_b)} \quad \mathbf{(3)}$$

Where 'w' denotes the weight of the queue and q is the instantaneous queue size. The drop function for RED are shown in fig.3. RED uses time-averaging means that recently most of the time the queue is empty, so RED will not to a sudden burst as if it were major congestion event. However if the queue remain near full, RED will react that the congestion occur and starts dropping the packets with higher rate [6].

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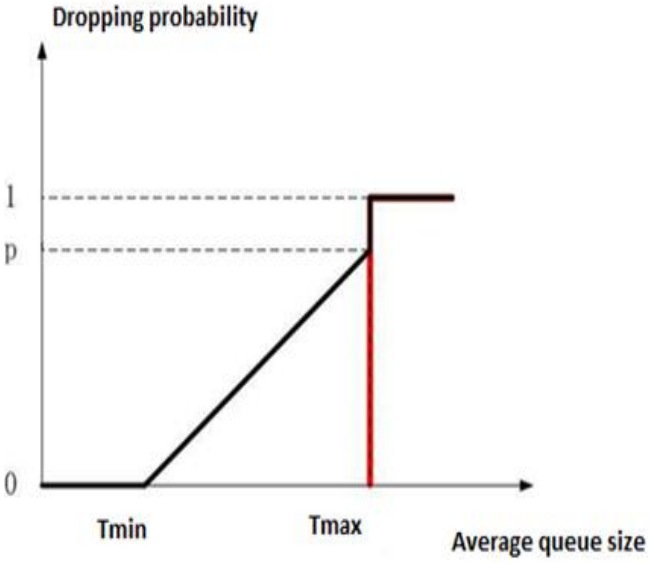

Fig.4: Drop function of RED

RED Algorithm

The detailed RED algorithm is taken from Sally Floyd and Von Jacobson [4].

Initialization:

```
avg <- 0
count <- -1
For each packet arrival
   Calculate new avg. Queue size avg:
      if the queue is nonempty
         Avg <- (1-w) avg + w* q
      else
         m <- f(time- q_time)
         avg <-  (1-w)^m * avg
 if min_th < = avg < max_th
        incerment count
         calculate probability p_a
            p_b <- max_p (avg - min_th) / (max_th - min_th)
              p_a <-  p_b / (1- count.p_b)
          with probability p_a :
            mark the arriving packet
              count <- 0
   else if max_th  < =  avg
            mark the arriving packet
            count <- 0
    else count <- -1
where queue become empty
     q_time <- time
where:
q_time:  start of the queue idle time
count:   packets since last dropped packet
max_p:   maximum value for p_b
p_b:     current packed marking probability
q:       current queue size
time:    current time
f (t):     a linear function of the time
```

FLOWCHART OF RED

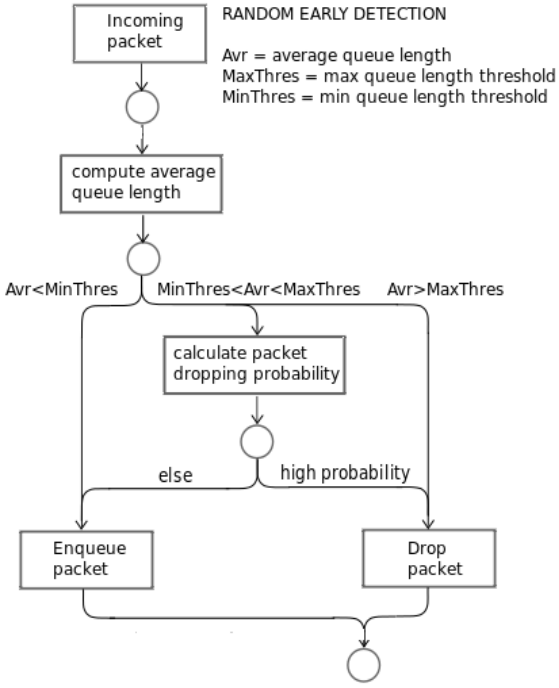

Fig.5: Flow Chart of RED
[http://en.wikipedia.org/wiki/File:Random_Early_Detection_algorithm_en.svg]

C. Comparison between RED and DROP TAIL

Drop Tail doesn't distribute buffer space fairly because it doesn't differentiate between the traffics of different flow. In contrast, RED can able to distinguish between the traffics of different flows. In RED per-flow buffer accounting is performed so that it can easily find out the flows that are misbehaving and take proper action accordingly, to ensure that buffer space is allocated fairly. In drop tail mechanism if TCP connection exists and if buffer exceeds the queue size will cause TCP global synchronization due to this network throughput is reduced whereas RED, introduces randomness to overcome the problem of global synchronization.

V. CONCLUSION

This paper briefly surveys, the various techniques used to improve the QoS in the internet. Also analyses the scheduling and buffer management techniques for QoS. The fundamental requirement of any internet QoS is *scalability.* In particular, where QoS is provided, the control and data path cost can vary greatly. It is observed that at present, due to wide range of parameters and different applications that impact system performance, no single congestion control mechanism is sufficient to solve all the problems. Incorporating, wireless transmission also finds some more issues in QoS, such as hand over and limited bandwidth. Thus more researches are required in this area of networking.

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