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A Study on Congestion Control Algorithms and Queuing Models in Computer Networks

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ABSTRACT

Modern computer networks, including the Internet, are being designed for fast transmission of large amounts of data, for which Congestion Control Algorithms (CCAs) and queuing models are very important. Without proper CCAs, congestion collapse of such networks is a real possibility. In Network the data packets that have different quality-of-service requirements. By buffering submitted packets at nodes we can regulate the rates at which data packets enter the network by using various queue models, although this may increase the overall packet delays to an unacceptable level. Therefore it is increasingly important to develop queuing mechanisms that are able to keep throughput of a network high with less packet delay, while maintaining sufficiently small average queue lengths. Several algorithms and models proposed recently try to provide an efficient solution to the problem. In one of these, Active Queue Management (AQM) with Explicit Congestion Notification (ECN), and various queue structures, packets generated by different data sources are marked at the network. In other algorithms, packets are dropped to avoid and control congestion at the network. This paper presents a brief and breadth wise survey of major CCAs and different queue models with different services designed to operate in the networks.

Keywords - Congestion Control, Queuing Models.

INTRODUCTION

In communication network when too many data packets arrive from many input lines and all need the same line to move out, a queue will build up. The data has to wait in the queue for transmission to its destination. However, as traffic increases the nodes are no longer able to cope and they begin losing data. At very high traffic, performance collapses completely and almost no packets are delivered. Therefore, congestion prevention is an important problem of packet switching network management

End-to-end congestion control in computer networks, including the current Internet, requires some form of feedback information from the congested link to the sources of data traffic, so that they can adjust their rates of sending data according to the available bandwidth in a given network.

Many problems in complex systems, such as computer networks, can be viewed from a control theory, which leads to dividing all solutions into two groups. 1) Open loop congestion control and 2) Closed loop congestion control

Open loop congestion control solutions attempt to solve the problem by good design, in essence to make sure it

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does not occur in the first place. Closed loop congestion control solutions are based on the concept of a feedback loop. The Transport Control Protocol (TCP) of the current Internet employs such an implicit feedback through timeouts and duplicate acknowledgements for lost packets. Relying only on the implicit or indirect feedback at the end nodes is not sufficient to achieve high efficiency in networks. Therefore we need more elaborate and explicit feedback mechanisms, such as Active Queue Management (AQM), to control or manage the congestion in networks. AQM employs a single Explicit Congestion Notification (ECN) bit in a packet header to feed back the congestion in the special high speed intermediate linking computers, to the end users or end nodes.

Feedback loop transfers the information about the congestion from the point where it is detected to the point where something can be done about it. The obvious way is for the router which detects the congestion to send a packet to the traffic sources, announcing the problem. Extra packets increase the load at precisely the moment that more load is not needed, namely when the subnet is congested.

2. CONGESTION CONTROL ALGORITHMS

The algorithms which try to avoid and control congestion at network are subject of our study in this paper, and they are collectively termed as Congestion Control Algorithms (CCAs).

AQM technology is mainly designed for congestion avoidance, i.e., AQM detects the congestion and notifies to the sender before it occurs[5,7]. Congestion will occur in this but they will be detected early. The sender will be notified by marking the packets using ECN bit or by dropping the packets. The ECN bit is mainly used to notify the end system about the congestion. For the further improvement in performance a new method called fast congestion notification (FCN) has been designed which notifies about the congestion in a faster way and controls the router efficiency.

Many active queue management schemes have been proposed in past and many recently for the TCP that improves the performance will study here about RED, GRED, FRED and ARED etc.;[4,6]

Drop Tail Algorithm

Drop Tail (DT) is the simplest and most commonly used algorithm in the current Internet gateways, which drops packets from the tail of the full queue buffer. Its main advantages are simplicity, suitability to heterogeneity and its decentralized nature. However this approach has some serious disadvantages, such as lack of fairness, no protection against the misbehaving or non responsive flows (i.e., flows which do not reduce their sending rate after receiving the congestion signals from gateway routers) and no relative Quality of Service (QoS). The QoS is a new the idea in the traditional “best effort” Internet as given in [4], in which we have some guarantees of transmission rates, error rates and other characteristics in advance. QoS is of particular concern for the continuous transmission of high- bandwidth video and multimedia information. Transmitting this kind of content is difficult in the present Internet with DT. Generally DT is used as a baseline case for assessing the performance of all the newly proposed gateway algorithms.

Random Early Detection Algorithm (RED)

RED uses a probability approach in order to calculate the probability that a packet will be dropped before periods of high congestion, relative to the minimum and maximum queue threshold, average queue length, packet size and the number of packets since the last drop. Drop tail algorithm does not fairly distribute the buffer space among the traffic flow. Drop tail algorithm can also lead to global synchronization. This problem is overcome in TCP RED.

TCP RED monitors queue size depending on the queue RED takes the decision of dropping the packet that is if the queue is empty all the packets are accepted, as queue becomes full the probability of dropping the

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packet also increases. When the queue becomes full all the incoming packets are dropped.

Variations of RED Algorithm

Some important variations of basic RED algorithm are i) GRED ii) FRED and iii) ARED algorithms [4].

GRED (Gentle RED)

It was proposed to deal with issues of RED like insensitive to traffic load and drain rate. The marking probability curve of the gentle variation of RED with maximum buffer size *B*. This algorithm is much more robust to the undesired oscillations in queue size and to the setting of parameters as compared to original RED.

FRED (Flow RED)

The idea behind FRED is to keep state based on the instantaneous queue occupancy of a given flow. If a flow continually occupies a large amount of the queue's buffer space, then it is detected and limited to a smaller amount of the buffer space. Thus fairness between flows is maintained. One of limitations of FRED, is the higher queue sampling frequency.

ARED (Adaptive RED)

The Adaptive RED (ARED) configures its parameters based on the traffic load. An on-line algorithm is given in. According to it, if the average queue size *qn* is in between *minth* and *maxth*, then the *maxp* is mutliplicatively scaled up by factor α or scaled down by factor β depending on current status of traffic load, with $\alpha = 3$ and $\beta = 2$. Recently another version of this algorithm was reported by [9]. In this version *maxP* is increased additively and decreased multiplicatively, over time scales larger then a typical round trip time, to keep the average queue length within a target range, which is half way between *minth* and *maxth*. Main advantage of ARED is that it works automatically for setting of its parameters in response to the changing load. Its limitation is that, it is not clear that which best and optimum policy of parameters changes.

Choke Algorithm

The choke algorithm uses similar parameters as RED. In the choke algorithm, whenever a new packet arrives at the congested gateway router, a packet is drawn at random from the FIFO buffer, and compared with the arriving packet. If both belong to the same flow, then both are dropped, else the randomly chosen packet is kept intact and the new incoming packet is admitted into the buffer with a probability that depends on the level of congestion. This probability is computed exactly the same as in RED. It is truly a simple and stateless algorithm which does not require any special data structure. However this algorithm is not likely to perform well when the number of flows is large compared to the buffer space.

Examples of congestion control techniques include:

Router Centric: Here the internal network routers are responsible for the packets to forward and which packets to drop. Queuing theory algorithm is a typical example of the router centric technique.

Host Centric: In this technique, the hosts adjust their behavior based on network condition observations. Example is the TCP congestion control mechanism.

Reservation Based: Here, the end host asks the network to reserve a small amount of capacity at the time flow is established. The reservation can be receiver based or sender-based.

Feedback Based: In this approach, the host begins transmitting without reserving any capacity at the time flow is established. However, the transmit rate is adjusted according to the feedback received. If the feedback is explicit, then it means the router is involved in the resource allocation scheme. If the feedback is implicit, the router drops the packets when they become congested.

Window Based: Here, the receiver sends an advertised window to the sender which is used to reserve buffer space in networks.

Rate Based: The sender's rate is controlled by the receiver indicating the bits per second it can absorb.

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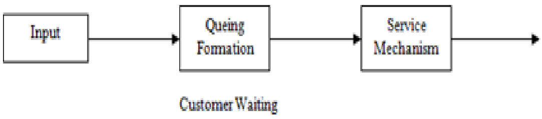
QUEUING MODELS

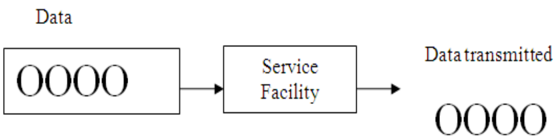
Data transmission with service rate in single queue, single server queuing model is analyzed. In this thesis, model proposed is single server queuing model at the network level. It focuses on long term average performance summarizing the complexities of transient congestion through the arrival and service rate distribution of data.

The basic definition of a queue is a waiting line for customers waiting to be serviced[1,2]. This basic scenario occurs in data communication networks where packets are operated upon. The queuing theory model could also be applicable in such scenarios to improve congestion control by efficient planning and calculating ones queuing algorithm depending on the model chosen.



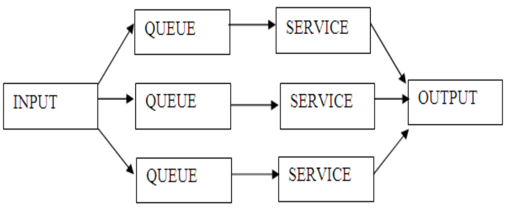
Single-Server Queuing Model

The server may be single channel in series or in parallel or mixed. Queue may be single queue or multiple queue system.

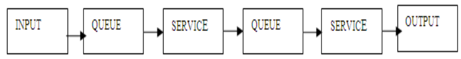


The framework of various typical queuing systems i) multiple queue multiple servers, ii) single queue multiple servers in series and iii) single queue multiple server in parallel.

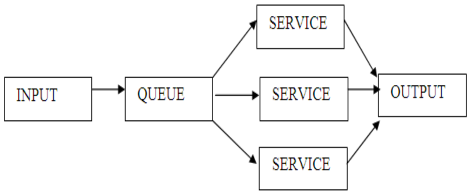
Multiple Queue Multiple Servers



Single Queue Multiple Servers in Series



Single Queue Multiple Servers in Parallel



Using queuing theory in congestion control has to do with Active Queue Management of data packets. There are various models used in queue theory such as

- Pure birth death model.
- Standard multi server model
- Single Earlang model.
- Finite queue multi server model

CONCLUSION

This paper briefly surveys congestion control algorithms, noting their strengths and weaknesses. It seems that at present no single algorithm can solve all of the problems of congestion control on computer networks and the Internet. There are various techniques and approaches to queue the packets arrived and destined at queuing node using queuing models. The most asked question in queue management is about the buffer size and in particular likelihood of networks with small buffer length, now gives us a new stage among which queue management strategy could be assessed. Various Active Queue Management techniques were defined in order to provide high transmission rate without dropouts and delays to balance between services to customers and economic considerations (not too many servers).

REFERENCES

[1]. P.K Frank, Networks of Queues with Customers of different types, Journal of Applied Probability, 1975,542-554.

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www.ijracse.com

[2]. V. Firoiu and M. Borden. A Study of Active Queue Management for Congestion Control. Proceedings of IEEE INFOCOM'2000, March 2000.

[3]. Patel SP, Gupta K, Garg A, Mehrotra P, Chhabra M. Comparative analysis of congestion control algorithms using ns-2. IJCSI International Journal of Computer Science Issues. 2011 Sep; 8(5(1)):89–94.

[4]. S. Floyd, R. Gummadi et al. (2001, Aug.). Adaptive RED: An Algorithm for Increasing the Robustness of RED‟s Active Queue Management.

[5]. Ryu S, Rump C, Qiao C. Advances in Active Queue Management (AQM) based TCP congestion control. Telecommunication Systems - Modeling, Analysis, Design and Management. 2004 Mar; 25(3):317–51.

[6]. Kiruthiga B, Raj EGDP. Survey on AQM congestion control algorithms. International Journal of Computer Science and Mobile Applications. 2014 Feb; 2(2):38–44.

[7]. Steven H. Low Sanjeewa Athuraliya, Victor H. Li and Qinghe Yin. REM: Active Queue Management. IEEE Network, 2001.

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