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Performance evaluation for DRED discrete-time queueing network analytical model

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Abstract

Due to the rapid development in computer networks, congestion becomes a critical issue. Congestion usually occurs when the connection demands on network resources, i.e. buffer spaces, exceed the available ones. We propose in this paper a new discrete-time queueing network analytical model based on dynamic random early drop (DRED) algorithm to control the congestion in early stages. We apply our analytical model on two-queue nodes queueing network. Furthermore, we compare between the proposed analytical model and three known active queue management (AQM) algorithms, including DRED, random early detection (RED) and adaptive RED, in order to figure out which of them offers better quality of service (QoS). We also experimentally compare the queue nodes of the proposed analytical model and the three AQM methods in terms of different performance measures, including, average queue length, average queueing delay, throughput, packet loss probability, etc., aiming to determine the queue node that offers better performance.

Keywords: Adaptive RED; Congestion control; Analytical model; Discrete-time queueing network; DRED; RED

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1. Introduction

With the rapid development in computer networks especially in the Internet, the competition of network sources on resources such as buffer space is increasing. This demand increase on the network resources may cause the router buffer to overflow and consequently results in congestion (Braden et al., 1998; Welzl, 2005). It has been shown experimentally that congestion deteriorates the network performance and may cause several drawbacks such as low throughput, high packets queueing delay, high packets loss rate and unfair share of network connections (Braden et al., 1998; Floyd and Jacobson, 1993; Welzl, 2005).

There are several methods developed in the network performance field for controlling congestion (e.g. Athuraliya et al., 2001; Braden et al., 1998; Brandauer et al., 2001; Feng et al., 2002; Floyd and Jacobson, 1993; Floyd et al., 2001; Ott et al., 1999). One of these methods is the drop-tail (DT) (Braden et al., 1998; Brandauer et al., 2001), which has been used for several years to control congestion in the Internet. The DT method depends on setting the routers buffers to maximum sizes and dropping packets when the routers buffers overflow. However, setting the routers buffers to maximum sizes may increase packets queueing delay. On the other hand, if the routers buffers are set to minimum sizes, the throughput will be decreased. DT method has several other drawbacks, including, lockout phenomenon, full queues, bias vs. bursty traffic and global synchronisation (Braden et al., 1998), where all of which contribute in degrading the Internet performance (Feng et al., 2002; Floyd and Jacobson, 1993; Floyd et al., 2001; Ott et al., 1999; Welzl, 2005). Many researchers in computer networks have proposed different active queue management (AQM) techniques (i.e. Athuraliya et al., 2000, 2001; Aweya et al., 2001; Brandauer et al., 2001; Feng et al., 1999, 2002; Floyd, 2000; Floyd and Jacobson, 1993; Floyd et al., 2001; Lapsley and Low, 1999a, b; Ott et al., 1999) in order to overcome some of the above limitations. Specifically, they aim to achieve the following:

1. Controlling the congestion at the routers buffers in the network.
2. Obtaining a satisfied quality of service (QoS) such as high throughput, low packets queueing delay and low packets loss rate.
3. Maintaining the queue length as small as possible.
4. Distributing fair share of the available resources among the network connections.

One of the known AQM algorithms is random early detection (RED) (Floyd and Jacobson, 1993) and its variants, including, adaptive RED (Floyd et al., 2001), gentle RED (Floyd, 2000), random exponential marking (REM) (Athuraliya et al., 2000, 2001; Lapsley and Low, 1999a, b), stabilised random early drop (SRED) (Ott et al., 1999), BLUE (Feng et al., 1999, 2002) and dynamic random early drop (DRED) (Aweya et al., 2001). In this paper, we introduce a new discrete-time queueing network analytical model based on DRED algorithm. The proposed analytical model can be utilised as a congestion control method in fixed and wireless networks. We apply our analytical model and simulation models of DRED, RED and adaptive RED methods on a network that has two-queue nodes (1, 2) in order to evaluate the efficiency of the proposed analytical model. In near future, we intend to apply our model on a network that consists of N queue nodes.

Furthermore, we compare between the proposed analytical model and (DRED, RED, adaptive RED) in order to determine the one which gives better QoS. We want also to