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Review paper on Analysis and Design of Proactive Active Queue Management Techniques with MATLAB Simulator on Various Performance Metrics

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ABSTRACT: Network congestion can seriously degrade the quality of services delivered to end users. Though a congestion control mechanism is conventionally implemented in end to-end systems to keep the core network flexible and simple, researchers are seeking other possibilities to effectively control congestion. The rapid development in hardware technology means that intermediate nodes, such as routers, gateways and switches are now powerful enough to handle extra tasks such as congestion control. Active Queue Management (AQM) controls congestion by handling incoming packets based on the status of the queue in an intermediate node. Random Early Detection (RED) is regarded as the first practical AQM scheme and has been recommended by IETF for deployment on the Internet. It can reduce end-to-end delay and prevent consecutive packet drops which usually results in oscillation in link utilization and TCP (Transport Control Protocol) global synchronization. Most AQM methods utilize Explicit Congestion Notification (ECN) to further improve the performance of control. In addition, Self Configuring Random (Adaptive) Early Detection (ARED), one emerging variants of RED. They all perform well in terms of queuing delay, packet drop rate and link utilization. These three performance indices are also known as network-centric (or router-based) metrics. However, a user is more interested in the end-to-end behavior of a network service such as end-to-end delay and packet loss ratio.

Keyword: AQM, NIC, RED, ECN, SRED, ARED, TCP, UDP

1. INTRODUCTION

In Internet routers, active queue management (AQM) is the intelligent drop of network packets inside a buffer associated with a network interface controller (NIC), when that buffer becomes full or gets close to becoming full, often with the larger goal of reducing network congestion. This task is performed by the network scheduler, which for this purpose uses various algorithms such as random early detection (RED), Explicit Congestion Notification (ECN), or controlled delay (CoDel). RFC 7567 recommends active queue management as a best practice.An Internet router typically maintains a set of queues, one per interface, that hold packets scheduled to go out on that interface. Historically, such queues use a *drop-tail* discipline: a packet is put onto the queue if the queue is shorter than its maximum size (measured in packets or in bytes), and dropped otherwise.

Active queue disciplines drop or mark packets before the queue is full. Typically, they operate by maintaining one or more drop/mark probabilities, and probabilistically dropping or marking packets even when the queue is short.Benefits of AQM Drop-tail queues have a tendency to penalise bursty flows, and to cause global synchronisation between flows. By

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dropping packets probabilistically, AQM disciplines typically avoid both of these issues. By providing endpoints with congestion indication before the queue is full, AQM disciplines are able to maintain a shorter queue length than drop-tail queues, which combatsbufferbloat and reduces network latency. Drawbacks of AQM Early AQM disciplines (notably RED and SRED) require careful tuning of their parameters in order to provide good performance. Modern AQM disciplines (ARED, Blue, PI) are self-tuning, and can be run with their default parameters in most circumstances.

2. TOOLS AND TECHNOLOGY

MATLAB AS SIMULATION TOOL : MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include: Math and computation. **MATLAB** (**mat**rix **lab**oratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. Developed by MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, Fortran and Python. Syntax The MATLAB application is built around the MATLAB language, and most use of MATLAB involves typing MATLAB code into the Command Window (as an interactive mathematical shell), or executing text files containing MATLAB code, including scripts and/or functions. Variables Variables are defined using the assignment operator, =. MATLAB is a weakly typed programming language because types are implicitly converted. It is an inferred typed language because variables can be assigned without declaring their type, except if they are to be treated as symbolic objects, and that their type can change Although MATLAB has classes, the syntax and calling conventions are significantly different from other languages. MATLAB has value classes and reference classes, depending on whether the class has *handle* as a super-class (for reference classes) or not (for value classes). Method call behavior is different between value and reference classes. For example, a call to a method

object.method();

can alter any member of *object* only if *object* is an instance of a reference class.

3. LITERATURE REVIEW

[1] G.Thiruchelvi and J.Raja (2008) wrote on "A Survey On Active Queue Management Mechanisms"

Congestion control mechanism is one of the key that keeps any network efficient and reliable for the users. Many mechanisms were proposed in the literature over theses years for the efficient control of congestion that occur in the network. Active Queue Management (AQM) is one such mechanism which provides better control in the recent years. It works at the router for controlling the number of packets in the router's buffer by actively discarding an arriving packet. Many schemes were proposed which give better delay performance and high throughput over different traffic conditions. In this paper an exhaustive survey is made on the AQM techniques that are proposed and the merits and short falls is presented In this research, they presented a survey on

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recent advances in the area of active queue management .The implementation of AQM is beneficial in a general network environment. Further we classified the mechanisms according to the type of metrics they used as congestion measure. From the survey we found that the performances of rate based AQM schemes are better than that of queue based schemes. The queue length of rate based scheme is less sensitive to the number of TCP connections than that of queue based schemes. Inclusion of more number of congestion measures in the existing rate based schemes such as AVQ,EAVQ may result in better performance in terms of , throughput, packet loss, link utilization.

[2] Kanchan Chavan, Ram G. Kumar, Madhu N. Belur and Abhay Karandikar (2009) wrote article on "Robust Active Queue Management for Wireless Networks"

Active Queue Management (AQM) algorithms have been extensively studied in the literature in the context of wired networks. In this paper, we study AQM for wireless networks. Unlike wired link which is assumed to have a fixed capacity, a wireless link has a capacity that is time varying due to multipath fading and mobility. Thus, the controller is required to meet performance objectives in the presence of these capacity variations. We propose a robust controller design that maintains the queue length close to an operating point. We treat capacity variations as an external disturbance and design a robust controller using H∞ control techniques. We also consider the effect of round trip time in our model. Our method of incorporating the delay into the discretized model simplifies controller design by allowing direct use of systematic controller design methods and/or design packages.

[3] Vandana Kushwaha, Ratneshwer(2014) wrote "A Review of Router based Congestion Control Algorithms"

This paper presents a study of Router based Congestion control approaches in wired network. As network is considered as a distributed system, any problem arises in such a system requires a distributed solution. Thus for good congestion control in the network we also need a solution distributed at source as well as router ends. The purpose of this study is to review the router based Congestion control research for wired network and characterize the different approaches to Congestion control design, by considering their advantages and limitations.

This work explores the literature review of router based congestion control algorithms in the context of wired networks. We understand that the identified issues and challenges regarding the router based congestion control algorithms may help in future research in this area. This initial proposition of such a review may be purposefully used by the academician/researchers and the corresponding useful feedback may be analyzed.

[4] Jahwan Koo, Seongjin Ahn, Jinwook Chung(2003) wrote "A Comparative Study Of Queue, Delay, And Loss Characteristics Of Aqm Schemes In Qos-Enabled Networks"

One of the major component in a QoS-enabled network is active queue management (AQM). Over the last decade numerous AQM schemes have been proposed in the literature. However, much recent work has focused on improving AQM performance through alternate approaches. This study focuses on an unbiased comparative evaluation of the various proposals. The evaluation methodology adopted is the following: we first define the relationship

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between the terminologies used in this paper, briefly introduce the queue, delay, and loss characteristics – a subset of network characteristics that can be used to describe the behavior of network entities, and give their mathematical description. Next, we present a method that would be a successful case study based on the NS simulation technique and simulation-based comparisons of AQM schemes chosen, which will help understand how they differ from in terms of per-node queueing information and per-flow end-to-end behavior. Simulation results showed that PI schemes, a feedback-based mechanism, can as- sist delay sensitive applications to adapt dynamically to underlying network and to stabilize the end-to-end QoS within an acceptable requirement. To understand this attribute and behavior is important for the proper design of queue disciplines, for the provisioning of queues and link capacity, and for choosing parameters in simulation

4. RESEARCH METHODOLOGY

The transport protocols considered in this work are TCP (Transmission Control Protocol) and UDP (User Datagram Protocol). TCP is used for the NRT (Non-Real Time) applications (Peer to Peer, FTP...), and UDP for time-sensitive applications (VoIP ...). The data applications are stored in the BE and AF queue while multimedia applications in the EF and AF queue. Consequently, AF queue receives data and multimedia streams. The goal of this work is to regulate a priori the Diffserv AF queue and avoid the over- flow. Considering the AF queue shared between UDP based multimedia applications and TCP based data transfer, the main idea consists in controlling TCP streams to guarantee transmission capacity of UDP packets. The most constraint application can then enjoy low buffers time delay and very few losses. In order to solve this problem, we design a congestion control mechanism based on Active Queue Management (AQM) techniques by using control theory. To this end a fluid model of TCP connection originally designed for wire-networks is proposed for satellite networks. Then, the design of a robust proportional integral (PI) and a robust dead time based controller are investigated. To avoid AF queue over flooding, TCP packets are voluntary dropped in the ST according to regulation rules. TCP connection throughput is then controlled and limited to protect UDP streams against unnecessary drops. The different methods are then simulated on matlab

Random early detection (RED), also known as random early discard or random early drop is a queuing discipline for a network scheduler suited for congestion avoidance. In the conventional tail drop algorithm, a router or other network component buffers as many packets as it can, and simply drops the ones it cannot buffer. If buffers are constantly full, the network is congested. Tail drop distributes buffer space unfairly among traffic flows. Tail drop can also lead to TCP global synchronization as all TCP connections "hold back" simultaneously, and then step forward simultaneously. Networks become under-utilized and flooded by turns. RED addresses these issues. RED monitors the average queue size and drops (or marks when used in conjunction with ECN) packets based on statistical probabilities. If the buffer is almost empty, all incoming packets are accepted. As the queue grows, the probability for dropping an incoming packet grows too. When the buffer is full, the probability has reached 1 and all incoming

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packets are dropped. RED is more fair than tail drop, in the sense that it does not possess a bias against bursty traffic that uses only a small portion of the bandwidth. The more a host transmits, the more likely it is that its packets are dropped as the probability of a host's packet being dropped is proportional to the amount of data it has in a queue. Early detection helps avoid TCP global synchronization. Robust random early detection (RRED) algorithm was proposed to improve the TCP throughput against Denial-of-Service (DoS) attacks, particularly Low-rate Denial-of-Service (LDoS) attacks. Experiments have confirmed that the existing RED-like algorithms are notably vulnerable under Low-rate Denial-of-Service (LDoS) attacks due to the oscillating TCP queue size caused by the attacks.[8] RRED algorithm can significantly improve the performance of TCP under Low-rate Denial-of-Service attacks.

5. CONCLUSION & FUTURE SCOPE

Active queue management (AQM) is an important function in today's core routers that will be required in the future optical internet core. A recently reported novel architecture for optical packet buffers is extended by implementing necessary AQM functions. The suggested AQM scheme is validated and explore via simulations. Network congestion can seriously degrade the quality of services delivered to end users. Though a congestion control mechanism is conventionally implemented in end to-end systems to keep the core network flexible and simple, researchers are seeking other possibilities to effectively control congestion. The rapid development in hardware technology means that intermediate nodes, such as routers, gateways and switches are now powerful enough to handle extra tasks such as congestion control. Active Queue Management (AQM) controls congestion by handling incoming packets based on the status of the queue in an intermediate node.

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