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A SURVEY OVER ANALYTICAL MODELS OF RED ALGORITHM

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Abstract

Network congestion control has become most challenging issues due to increase of the total number of internet users and applications. At the time, the active queue management algorithms have a vital role in performance of the internet congestion control process. One of the common active queue management algorithms used is random early detection (RED) This paper gives a survey for the searcher development of network congestion control in AQM algorithm by analytical model in the past twenty years. The evolution indicator of the perfect congestion control is introduced, example fairness, stability, efficiency, etc. Several network models and analytical methods are also given for the development of congestion control, such as the markov model, the control model, the chaos model.

Keywords: Congestion Control, random early detection, markov model, chaos.

Introduction

When congestion occurs, the total requests from a network source (e.g. bandwidth connection) can be beyond the current capacity. The result of such status, increasing delay and Packets the probability of being deleted and congestion collapse, which in case usually fully occupied link capacity but throughput is extremely low. One of solve-intuitive to heavy congestion of network resources is increasing, but in ref [2] has shown that large memory, fast processors, high-speed connections cannot solve the problem of congestion in computer networks. Therefore, despite the increase in network capacity, a proper congestion control mechanism is also an essential requirement. The purpose of the study areas, congestion control, design and analysis of distributed algorithms for sharing network resources among competing users, Purpose, adapt with requests of existing resources, to reduce congestion and prevent unfair allocation of resources. Network congestion control in the Internet, there are two basic components. The first component is the source algorithm, which is implemented in TCP dynamically adjusts the transmission rate according to the intensity of route congestion. AQM is a second component that runs on the router, and router update information on congestion. The transfer in the feedback currents, explicitly or implicitly as packet loss, delay or packets will be marked. Today, the most popular algorithm for active queue management in routers, used are algorithms, RED [1]. RED algorithm to solve problems Droptail was proposed. Unlike Droptail, when filling queue, the final package will be deleted, RED based on the average queue length, has Packages as probable will be deleted. Reasons packets are randomly dropped Is the phenomenon of global synchronization will be deleted. RED average queue length control and manages to queue overflow must be avoided. RED algorithm has two components, the first component to estimate the average queue length using the average Weighted exponential, which can be interpreted as a low-pass filter. The second part of the task of deciding on the received package has been removed. How to calculate the probability, expressed in Equation 1. Figure 1 describes the behavior of RED.

$$P_d = \begin{cases} 0 & if \quad avg \le min_{th}, \\ \dfrac{avg - min_{th}}{max_{th} - min_{th}}\, max_p & if \quad min_{th} \le avg \le max_{th} \\ 1 & if \quad avg \ge max_{th} \end{cases} \tag{1}$$

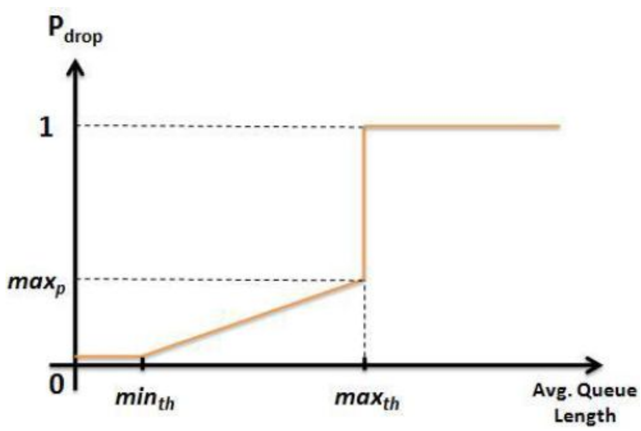

Fig. 1. Describe RED algorithm

Markov process is a stochastic process whose dynamic behavior is such that probability distributions for its future development depend only on the present state and not on how the process arrived in that state [4]. Chaos is the chaotic dynamic system defined so that for a short time, but long-term behavior is predictable is unpredictable and is sensitive to initial conditions.

There are two main divisions in control theory, called, classical and modern, which have direct implications all the control engineering applications. The domain of classical control theory is finite to single-input and single-output (SISO) system design, except when analyzing for disturbance rejection using a second input. The system analysis is carried out in the time scope using differential equations, in the complex-s domain with the Laplace transform, or in the frequency scope by transforming from the complex-s domain. Many systems may be imagined to have a second order and single variable system response in the time scope. A controller sketching using classical theory often requires on-site tuning due to incorrect design approximations. Yet, causes the easier physical implementation of classical controller designs as compared to systems designed using modern control theory; these controllers are preferred in most economic applications.

Research of congestion control model

1. Model base on Markov

A. Markovian Model of RED Mechanism [3]

In this study, develop simple Markovian model for the RED buffer management schemes. They examine the impact of RED on the loss rate and the mean delay. In this direction they have changed the formula for calculating the average queue length at which the value of w is not fixed expressed in Equation 2.

$$avg_{new} = \begin{cases} (1-\mathrm{w}) \times \left(n_2 + \frac{\mathrm{Down}+\mathrm{up}}{2}\right) + \mathrm{w} \times (n_1+1) & n_1 \neq 0 \\ (1-\mathrm{w})^{\frac{\mu}{\lambda}} \times \left(n_2 + \frac{\mathrm{Down}+\mathrm{up}}{2}\right) & n_1 = 0 \end{cases} \quad (2)$$

$$\begin{cases} \mathrm{Down} = (\mathrm{i}-3) \times 0.25 & \text{if } n_i = 1\ \forall \mathrm{i} \in \{3,4,5,6\} \\ up = \left((i-3)+1\right) \times 0.25 & \text{if } n_i = 1\ \forall \mathrm{i} \in \{3,4,5,6\} \\ \mathrm{Down} = \mathrm{up} = 0 & \text{if } n_i = 0\ \forall \mathrm{i} \in \{3,4,5,6\} \end{cases} \quad (3)$$

Transition from ni to ni +1 with λ × (1- pd) are equal. Number of state model Markov is buffer size. (n1,n2, n3,n4,n5,n6) to (n1+1, n'2, n'3, n'4, n'5, n'6)

B. Markove Model Based Congestion Control for TCP [5]

This study used markov model with 3 states. It models the behavior of the average queue size as the Markov model with three states and uses the ARED's recommendation of automatically setting the RED's parameter max_p to improve connection throughput with reduced packet loss. State 1 occurs when the average queue length is less than minth and state 2 is between minth and maxth and state three occurs when the average queue length is greater than maxth, Between the three state 9 to transfer there. P is matrix probability of Markov chain. Algorithm to obtain probability state are given in Table 1.

$$P_{ij} = \begin{bmatrix} poo & p01 & p02 \\ p10 & p11 & p12 \\ p20 & p21 & p22 \end{bmatrix} \quad (4)$$

Table. 1 Algorithm probability of states[5]

```
if (old_ave < th_min && new_ave < th_min)
n00 = n00 + 1.0;
if (old_ave < th_min && (new_ave >= th_min && new_ave < th_max))
n01 = n01 + 1.0;
if (old_ave < th_min && new_ave >= th_max)
n02 = n02 + 1.0;
if ((old_ave >= th_min && old_ave < th_max) && new_ave < th_min)
n10 = n10 + 1.0;
if ((old_ave >= th_min && old_ave < th_max)&& (new_ave >= th_min && new_ave < th_max))
n11 = n11 + 1.0;
if ((old_ave >= th_min && old_ave < th_max&& new_ave >= th_max)
n12 = n12 + 1.0;
if (old_ave >= th_max && new_ave < th_min)
n20 = n20 + 1.0;
if (old_ave >= th_max && (new_ave >= th_min&& new_ave < th_max))
n21 = n21 + 1.0;
if (old_ave >= th_max && new_ave >= th_max)
n22 = n22 + 1.0;
n0 = n00+n01+n02
n1 = n10+n11+n12
n2 = n20+n21+n22
p00 = n00/n0;    p01 = n01/n0;    p02 = n02/n0;
p10 = n10/n1;    p11 = n11/n1;    p21 = n21/n1;
p20 = n20/n2;    p21 = n21/n2;    p22 = n22/n2;
```

After get probability of states, α and β obtain. Algorithm to obtain α and β are given in Table 2.

Table. 2 Algorithm obtain α and β [5]

```
if (now > lastset + interval) {
if (ave <= th_min+part) {
if (max_p <= 0.01) {
alpha=p01*(p0+p2); beta=p00*p1;
max_p=max_p*beta+alpha; lastset=now;}
else if (max_p >= 0.5) {
beta=(p22-p21-p10)*p1;
max_p=max_p*beta; lastset=now;}
else {
beta=(p11-p10)*p1;
max_p=max_p*beta; lastset=now;}
}
else
if (ave>th_min+part && ave<th_max-part){
if (max_p <= 0.01){
alpha=p01*(p0+p2);
max_p=max_p+alpha; lastset=now;}
else if (max_p >= 0.5){
beta=(p22-p21)*p1;
max_p=max_p*beta; lastset=now;}
else {
alpha=p12*(p0+p2); beta=p11*p1;
max_p=max_p*beta+alpha; lastset=now;}}
else if (ave >= th_max-part){
if (max_p <= 0.01){
alpha=(p01+p12)*(p0+p2);
max_p=max_p+alpha; lastset=now;}
else if (max_p >= 0.5)
{alpha=p21*(p0+p2); beta=p22*p1;
max_p=max_p*beta+alpha; lastset=now;}
else {
alpha=p12*(p0+p2);
max_p=max_p+alpha; lastset=now;}}}
```

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C. A Finite- State Markov for Statistical Loss across a Red Queue[6]

This study used Analytical methods for monitoring packet loss in the queue. Used of Markov model with recursive equations. 3 Markov models are proposed , the first model included two-state " GOOD " and "BAD", GOOD. Second model included 3 state, GOOD state occurs when the average queue length is less than min_{th}, "Intermediate" state is between min_{th} and max_{th} BAD state occurs when the average queue length more than max_{th}. The third model is a four state include "GOOD ", "BAD", "Intermediate good", "intermediate bad" intermediate state in second model divided into two state. Third model better than other two models. When min_{th} and max_{th} close election, more transitions from Intermediate to BAD and from Intermediate to GOOD. They also note that there are more fluctuation in the average queue size as w_q become larger. Using the simulation results confirm the validity of the proposed model.

D. A Novel Markov Analytical Model for the TCP/AQM Systems [7]

This study used Markov models by discrete time. In this model, the system can be divided into two slots, which includes queuing model of the router is the bottleneck and TCP window size models and each model are analyzed. Finally, by setting their slots are combined and an analytical model of TCP / AQM are presented in Figure (3-3) is given. This model is implemented using the simulation matlab. They compared its solution to the results of NS-2 simulated solution. The close response between the simulations NS-2 with matlab verify proposed model.

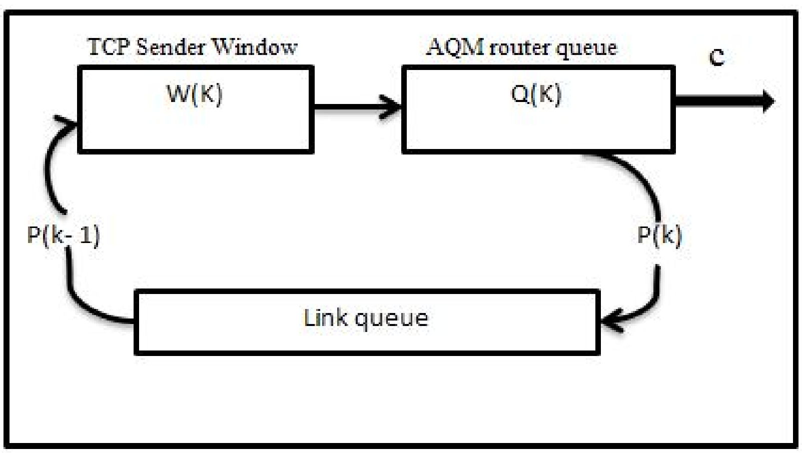

Fig. 2 System model in a time slot

E. A Statistical Study of Loss-Delay Tradeoff for RED Queues [9]

This study used the analytical method for fine-tuning RED parameters. Through an analytical study aimed at addressing the delay and loss tradeoff of the RED queuing discipline. They provide a two-phase iterative solution to the problem identify the setting of the RED parameters. The queue size shown by K, it is mapped to the K-state Markov, which is shown in Fig 3.

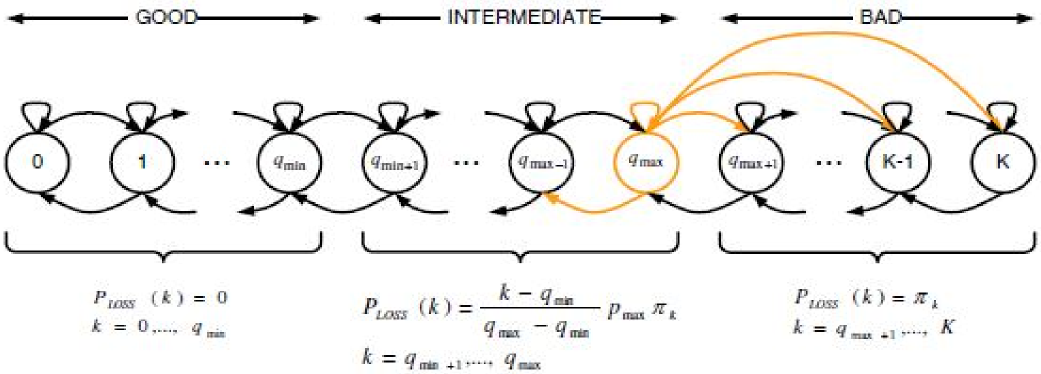

Fig. 3 queuing system Markov chain

The purpose of this paper is to minimize PLOSS and PDELAY ≤ DMAX. PLOSS is probability packet loss and DMAX range high of statistical queuing delay. For this operation used two phases. In the first phase max_{th} and min_{th} are held constant, p_{max} get. During the second phase, based on phase constant p_{max} consider max_{th} and receive min_{th}. This way Raise the efficiency of the system. Iterative Optimizing Algorithm given in Table 3.

Table. 3 Iterative Optimizing Algorithm [9]

/* Step 1: Initialization */
Initialize ($qmin \leftarrow$ _K/3_), ($qmax \leftarrow$ _2K/3_), grid size width ($\varepsilon \leftarrow 1$), initial iteration number ($i \leftarrow 0$), maximum iteration number ($imax \leftarrow 103$), intermediate variables ($L3 \leftarrow 0$), ($L4 \leftarrow 0$), and stoppage criterion variables ($L1 \leftarrow 0$), ($L2 \leftarrow 1$), ($\delta \leftarrow 10-6$).
repeat
/* Step 2: Calculate $p{*}max$ ***/**
Calculate the optimal value of $p{*}max$ from Equation (14)
/* Step 3: Calculate $q{*}min$ **and** $q{*}max$ ***/**
Reset ($L3 \leftarrow 1$).
for ($qmax = 1$ *to* K) { **do**
$qmin \leftarrow (qmax - \varepsilon)$
if Constraint function (10) is satisfied **then**
Store the value of the cost function (9) in $L4$
end if
if $L3 > L4$ **then**
($q{*}min \leftarrow qmin$), ($q{*}max \leftarrow qmax$), and ($L3 \leftarrow L4$);
else
Break
end if
end for
/* Step 4: Update Stoppage Criterion Variables */
Set ($L1 \leftarrow L2$) and ($L2 \leftarrow L3$)
Set ($i \leftarrow i + 1$)
/* Step 5: Check Stoppage Criterion */
until {($|L1-L2|L1 < \delta$) or ($i > i_{max}$)}

2. Model base on control theory

On the use of a full information feedback to stabilize RED [10]

This study to resolve the instability of the active queue management algorithm for detecting and responding to congestion used both the average queue length and the instantaneous queue length queue. The measure of the average queue length of the system prevents the premature reaction and congestion long into the calculations and decision making, use of instantaneous queue length causes early diagnosis of sudden changes and avoided of the reaction with delay. The proposed congestion control function to measure and calculate the probability of packet removed in equation (5) is given.

$$p(t)= (\alpha*(\frac{avg(t)- min_{th}}{max_{th}- min_{th}}) + \beta * (\frac{avg- min_{th}}{max_{th}- min_{th}})) * max_p \quad (5)$$

Using control theory values α and β is set to guarantee the stability of congestion control process.

3. Model base on chaos

IDFC: A new approach to control bifurcation in TCP/RED [8]

This research a new method was introduced to control the bifurcation phenomenon in internet congestion. This model was inspired from delayed feedback controller (DFC), a common method in control of delayed system. Proposed a new equation for calculate average queue length in equation 6.

$$q_{new}^{ave} = \begin{cases} (1-w_q)q_{new}^{ave} + w_q \max\left(\frac{NK}{\sqrt{P}} - \frac{cd}{M}, 0\right) & if\ p \neq 0 \\ (1-w_q)q_{new}^{ave} + w_q\left(awndN - \frac{cd}{m}\right) & if\ p = 0 \end{cases} \quad (6)$$

In Eq. (6), N, p and C are the number of TCP connections, drop probability and capacity of the link between the two routers, respectively. Cause bifurcation is w_q, q_{min}, p_{max}. Result of simulation shown IDFC phenomenon chaos Elimination in p_{max} and q_{min} but using this controller, bifurcation and chaos against wq happen much later.

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