A novel approach for congestion control in wireless network

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***Abstract*— Congestion control in packet switching networks became a high priority in network design and research due to ever-growing network bandwidth and intensive network applications. Dozens of various congestion control strategies have been proposed, and more are forthcoming. Based on control theory concepts congestion control can be viewed as control policy to achieve prescribed goals (e.g., round-trip delay or throughput) in a distributed network environment. This paper discusses the advantages, disadvantages and the applications of various congestion control protocols for wireless networks. It explores the motivation behind the design of congestion control protocols which is suitable to large scale wireless network and abolish drawbacks of the most widely accepted two algorithms of TCP and RCP.**

***Keywords*— TCP- Transmission control protocol, RCP- Rate control protocol**

1. Introduction

Congestion in packet switched network is a state in which performance degrades due to the saturation of network resources such as communication links, processor such as communication links, processor cycles, and memory buffers.

Adverse effects resulting from such congestion include the long delay of message and possible network collapse, when all communication in the entire network ceases. Network congestion is like traffic jams in big cities and is becoming real threats to the growth of network interconnections and communication applications

A large number of various congestion control schemes have been implemented in real networks. Consider the networking situation from ISP's viewpoint. When all the internet users start sending data at their full speed, they may create bottleneck condition. In metro cities, much of the corporate work is depended on Internet especially during crowded office hours. ISP's networks, when combined for the entire city, makes it a large crowded network, where end users are generally wireless making it even a larger scale wireless network. The interesting part of data network is that, the traffic is bursty and in most situations, bursty traffics are unpredictable and random by behaviour. The irregular pattern of traffic makes the situation even more difficult to control and networking processes induce complexity into the computation as well. In such a situation there is an immense need of researchers' contribution to the solution for this problem. By means of this paper, the authors have shown the strategy of congestion control and tried to improve the situation by means of new approach based on existing protocols like RCP and TCP[4]. Here we come up with a novel approach enhanced rcp in wireless network.

2. TCP

TCP fulfills two important functions: (1) Reliable and ordered delivery and (2) Congestion control. Congestion can be detected by Packet loss or Packet delay. Solution of this problem is limiting sender's transmission rate. Now question arise, at what rate should the data be sent for the current network path? [5, 8]

The approach given in [1] paper improves the bandwidth utilization for each epoch. It improves the fairness and throughput of the network. The basic concept of this algorithm is based on the decrease in the initial window size for occurrence of every congestion event.

$$w(t+1) = w(t) + \alpha, \text{ if congestion is not detected,}$$

or

$$w(t+1) = (w(t) * \beta) + k, \text{ if congestion is detected,} \quad (1)$$

Where k is the increment in congestion window size (w) in t cycles or epoch. The graph (see fig-2.1) shows the bandwidth utilization in improved Additive Increase Multiplicative Decrease (AIMD) for each round trip time. When the flow exceeds the threshold, only the initial window is decreased, this utilizes the bandwidth more for each RTT as compared to general additive increase multiplicative decrease (GAIMD).

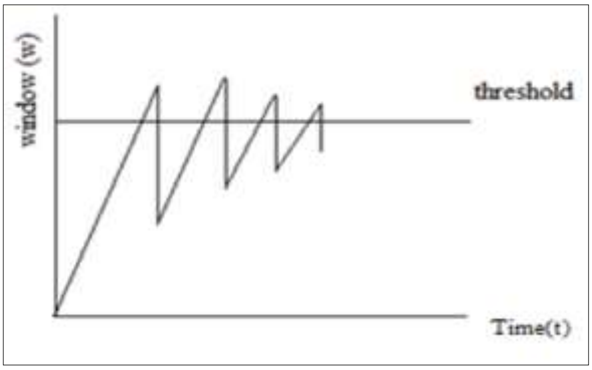

Figure 2.1 performance of Improved AIMD[1]

Partially Improved AIMD gives the fairness 1+log(n) approximately. This is reasonably good. The limitation of improved AIMD is that the algorithm does not include the different arrival time of flows.

3. RCP+

Authors [2] described a simple congestion control algorithm called RCP+ which reduces flow completion time for diverse flow types to large extend for broad range of traffic conditions and network situations. In RCP+, unlike XCP, RCP they are not following feedback mechanism but they are adapting the ancient congestion window based congestion control mechanism. The reason behind sticking to the congestion window for congestion control is that, while each second new flow are entering and moving out of network, it is tough to obtain exact number of flows at particular RTT. This inspired us to stay with congestion window based mechanism instead of feedback based mechanism. We set the _cwnd' value completely based on the rate computation, but that doesn't impose any overhead over the router. In addition, we are setting the value of _maxcwnd' to obtain the better start for our optimum data rate calculation at the initial stage.

RCP+ wins upon existing congestion control algorithm with three characteristics, 1) RCP+ is more flexible to be implemented on wireless networks in comparison of RCP. 2) It allows multiple variants of TCP to co-exist in the same networks with RCP+ and work with each other smoothly. 3) And it performs well in Large scale wireless networking scenario too.

The equation of RCP+ can be given as,

$$N(t) * R(t) = (\alpha*C - \alpha*y(t) - (\beta*q(t)/d)) \quad (2)$$

Where,
d = moving average of RTT per interval,
R(t) = last updated rate,
y(t) = existing traffic observed in network,
q(t) = the instantaneous queue size,
C = link capacity and
N(t) = number of flows.

α (alpha) is a stability parameter and β (beta) is a performance parameter added to the equation to make the rate stable and not aggressive.

Thus, the equation gives us the desired aggregate rate change in presence of traffic in the next interval. Here, Rate kept same for each flow. "cwnd" congestion window value is having proportionate relationship with the rate and so, "cwnd" value is set on the bases of the Rate computed. RCP+ is very acute to packet loss. This equation was obtained by manipulating Rate equation of RCP [5, 8] and XCP

4. Proposed Approach

Our proposed approach is based Improved AIMD and RCP+ algorithm. In our proposed approach we use congestion window mechanism of Improved AIMD algorithm to use the spare capacity of congestion window after occurrence of congestion event. The limitation of improved AIMD is that the algorithm does not include the different arrival time of flows.[1]. So we have used modified equation of RCP+ algorithm.

RCP+ algorithm is implemented based on the theory of RCP. RCP+ is having the added advantage of coexistence with other wired and wireless TCP, XCP, RCP and DCCP protocols. RCP+ is flexible like TCP and so is expected to have wide implementation over current demands of Internet. [2]. In the theory of RCP there is a concept of queue. RCP was originally implemented in wired network. In wireless network the essential point is traffic is in bursty nature. Hence it is difficult to use queue concept while going to practical simulation. So we modified the equation of rate change.

Here we come up with a new proposal of congestion control scheme enhanced RCP. Here we use Improved AIMD mechanism as well as modified rate change equation of rcp+. Our aim is to gain benefits of both schemes by eliminating each other's demerits.

Initially we defined congestion window size 4 MSS and start data transfer. If acknowledgment is received means no congestion and increase congestion windows size by +1 and transfer data

If acknowledgment is not received then congestion would likely to be occurred then decrease congestion window size by equation

$$Cwnd = (cwnd * 1/2) + K \quad (3)$$

Where, k is the increment in congestion window size (w) in t cycles or epoch

Calculate the rate change by equation

$$Rate = (\alpha*C - \alpha*y(t))/N(t) \quad (4)$$

Again check if rate is greater then congestion window size then increase congestion window size otherwise transfer data.

Algorithm

1) Initially set congestion window size 4 MSS
2) Data transfer

3) If acknowledgement is received increase congestion window size by cwnd = cwnd +1 and repeat step 2
4) Otherwise decrease congestion window size by equation Cwnd = (cwnd *1/2) + K
5) Calculate the rate change by equation Rate = (α*C - α*y(t))/N(t)
6) If rate > cwnd then go to step 2
7) Otherwise transfer data

5. IMPLEMENTATION

We have implemented proposed model in NS-2 simulator and version is 2.35 [6,7]. Following table 1.1 present the configuration details of the simulation.

Table 1.1 Configuration Table

Layer	Parameter	Values
Application	FTP	FTP over TCP agent and RCP+
Configuration	No of nodes	10 to 50 incremental
Mobility	Maximum Speed	10 Mbps
	Pause time	2 s
	Simulation time	500 s
Traffic	type	TCP/CBR
	Rate	4.0 Mbps
	Maximum Connections	8
Routing	protocol	AODV
MAC	Mac	802_11
PHY	Propagation model	Two ray ground
	Antenna	omni
System	OS	Ubuntu 12.10
	processor	Intel(R) Core(TM) i5

Table 1.2 shows the statistics of throughput, packet delivery function and routing overhead of performance of proposed model

Table 1.2 Performance Statistics

nodes	PDF (r/s)	Throughput	Routing overhead
10	0.9803	232.22	0.080
20	0.9946	235.23	0.145
30	0.9954	236.01	0.214
40	0.9964	236.14	0.207
50	0.9952	236.33	0.338

Based on this statistics the graphs of packet delivery ratio, throughput and routing overload are given in following figures

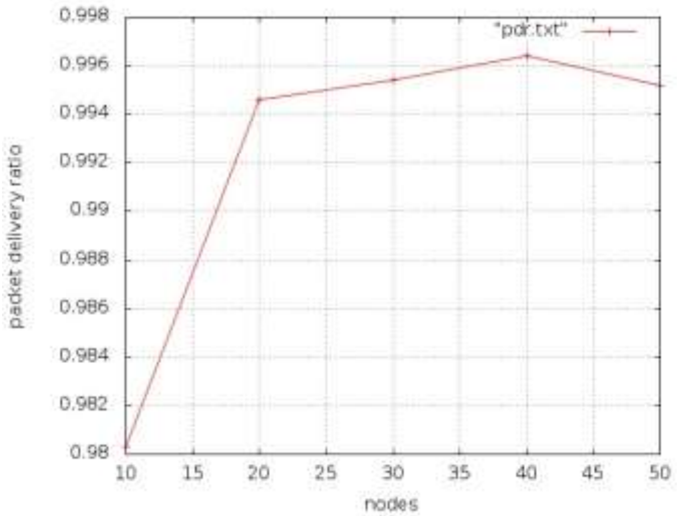

Figure 5.1 Packet delivery ration graph

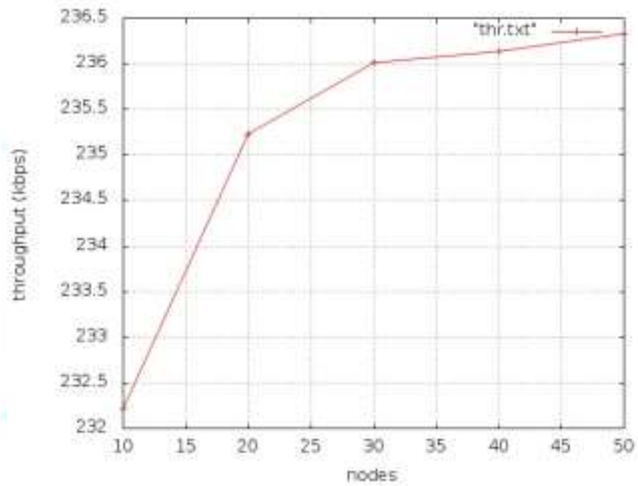

Figure 5.2 throughput graph

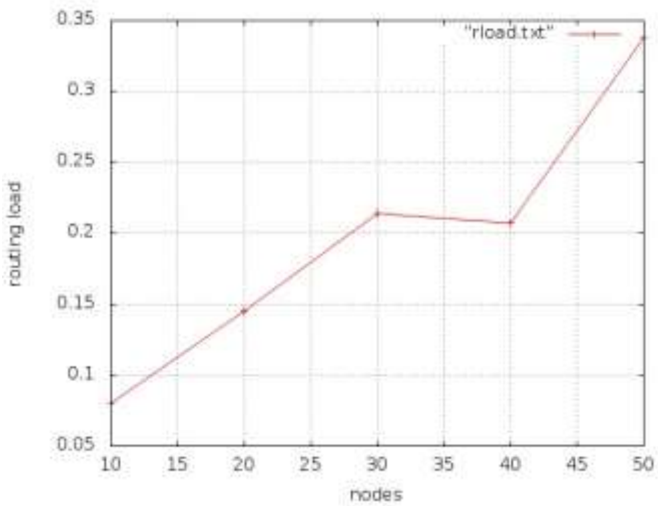

Figure 5.3 Routing load graph

6. Conclusions

In this paper various protocols used for congestion control in wireless network are presented and discussed their pros and cons. We have proposed a model and mechanism for congestion control, enhanced RCP, which is window based strategy that has its fundamentals associated with RCP and TCP. We also done simulation of proposed model and evaluate it's performance. From the results we conclude that proposed model performs best in wireless network.

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