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An Analysis of Congestion Control Algorithms and Structured Wireless Network

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Abstract

The concept of digital India increasing the internet very rapidly. Each and every one try to access internet facilities but the network service providers are fail to maintain their network availability to each and every where to everyone with the same consistent speed. The number of users can not able to access the internet facility with same speed due to heavy traffic generated by the lot of mobile communication devices. Due to heavy traffic the congestion occurs and data packets are dropped. The service providers are increase their devices through high speed and large bandwidth but the protocols are remain unchanged. So in this direction lot of research required. The appropriate reason behind the congestion and slow data speed is that the TCP congestion control algorithms are not much efficient to control the congestion occurrence and low bandwidth at receiver end or intermediate routers. This article focused on the review of TCP congestion control mechanism and comparative analysis of congestion control algorithms.

Keywords: Congestion control, Transmission Control Protocol (TCP), wireless mobile network, bottleneck bandwidth.

INTRODUCTION

Over the past decades, lot of work has been already done to enhance the TCP performance and the result many different congestion control algorithms. The number of congestion control algorithms are already developed and implemented after finding

some enhancement result over the existing congestion control algorithms [1]. The researchers comment on the heterogeneous resource allocation to achieve the full efficiency of the devices for load balancing. The proposed load balancing algorithm compared with others to check their credibility. The load balancing is the major problem to achieve the maximum through put and make network congestion free but in real life load balancing applied, thereafter congestion occurs and required best approach to resolve the congestion [2]. In this research article the authors proposed an algorithm for packet routing in wireless sensor network to increase the performance of the WSN, in this article the focus to reducing the packet loss rate during routing, reduce energy consumption and increased the throughput [3]. The wireless network is having more challenges to the wired network. The TCP congestion control algorithms are successfully implemented and tested in wired computer network but TCP face some challenges in wireless mobile communication and mobile Ad-Hoc networking. Some of the main challenges are releted to wireless mobile communication as open network architecture, shared medium, high speed of mobile nodes, dynamic topology, limited energy, difficulty to find misbehaving mobile device etc. [4-6]

The implementation and comparing them with other congestion control algorithms is troublesome without network simulators. In the real world scenario, it is very difficult to compare algorithm performance on the basis of actual devices it is possible with the simulators it is less time to consume and less expensive and given the moral as actual results. Computer simulator provides valuable insight into potential implementation before extending the considerable effort that may be required to build a technology simulator allow us to measure and compare the existing algorithm as well as we can introduce a new algorithm and compare in light of existing algorithms. It provides a much more flexible way to implement a new algorithm and finding out the related result on the basis of some existing networking topology [7]. Today network devices like smart mobile phone and servers are very well processing capabilities and interact with multiple network interfaces due to support of different wire/wireless technology. The TCP congestion control algorithms are classified on the traffic basis, time basis, path basis[8].

Wireless sensor networks can also be classified in two types as structured and unstructured. The structure wireless network has deployed in a planned manner and the numbers of mobile nodes are placed in a structure. The structure wireless network maintenance is easy and low cost applied for up gradation. In this categories the homogenous and heterogeneous network are working perfectly. Most of the public places are having structured wireless sensor network like railway station, airport, hospital, supermarket etc. Whereas the unstructured wireless network no topology specified, no pre-plan for deployment of mobile nodes, hard to maintained and required higher cost to maintain. Unstructured wireless mobile network very less used it is known as Mobile Ad-Hoc network, Vehicular Ad-Hoc network , Aircraft Ad-Hoc

network etc.[9]

It is very well known that TCP (Transmission control protocol) performed very well in varied networking environments wired or wireless or both. The TCP performance is throughput and fairness different in wired and wireless network scenario. In wireless mobile network, TCP performance is poor than the wired TCP. To improve TCP performance in wireless network reviewed different TCP congestion control algorithms and mitigation of congestion control.[10]

TCP CONGESTION CONTROL RELATED WORK

Based on congestion control the researchers contributed with their algorithms to improve the TCP congestion control using different mechanism. On the basis of this study we find out some facts related to TCP. First of all TCP work in two phases in which first phase is known as congestion prevention and another is called congestion recovery.

Congestion prevention:

In this phase, TCP increasing the congestion window size and try to achieve maximum through put or try to transmit data at maximum available bandwidth. To probing the channel is to maximum bandwidth with increasing the congestion window size increment tills the congestion or time out delay not occurs.

Congestion Recovery

In this phase TCP recover congestion very fast to slow down the transmission speed and reduced the congestion windows size rapidly. This is going on rapidly until next successful acknowledgement not received. In this second phase the most of researches contributed in different manner. They find out how to improved the recovery mechanism or how to transmission continue going on without congestion, how to detect the maximum channel bandwidth.

In the following figure 1 shows the flow of TCP congestion control algorithm and their different stages. In open stage data packets are transmitted and received the successful delivery acknowledgement. In TCP disorder stage there are two kind of disorders either time related or packet sequence no related. Next stage detects the losses of data packets through the acknowledgement. If packet loss detected the fast congestion recovery required and changes the congestion windows size or slow down data transmission speed.

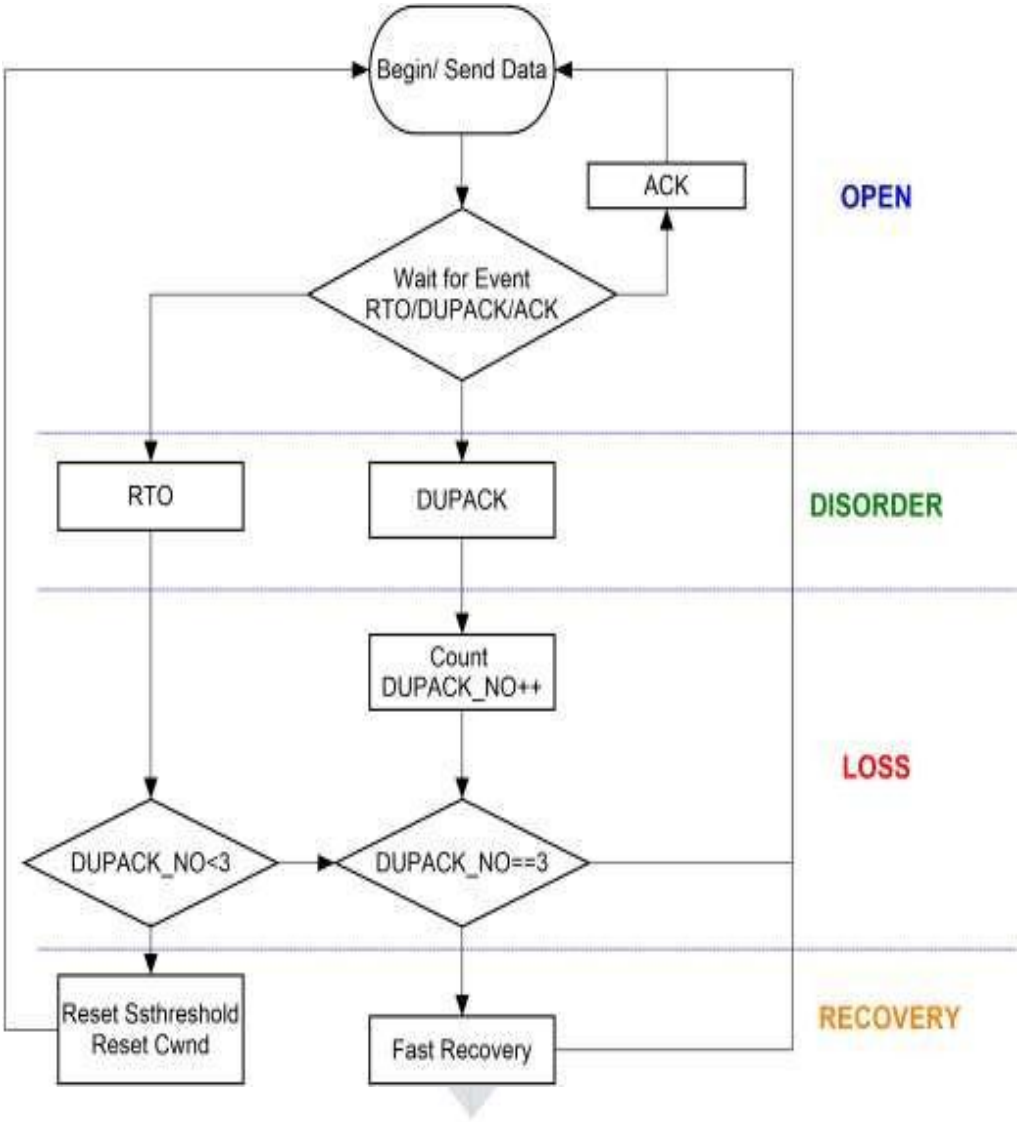
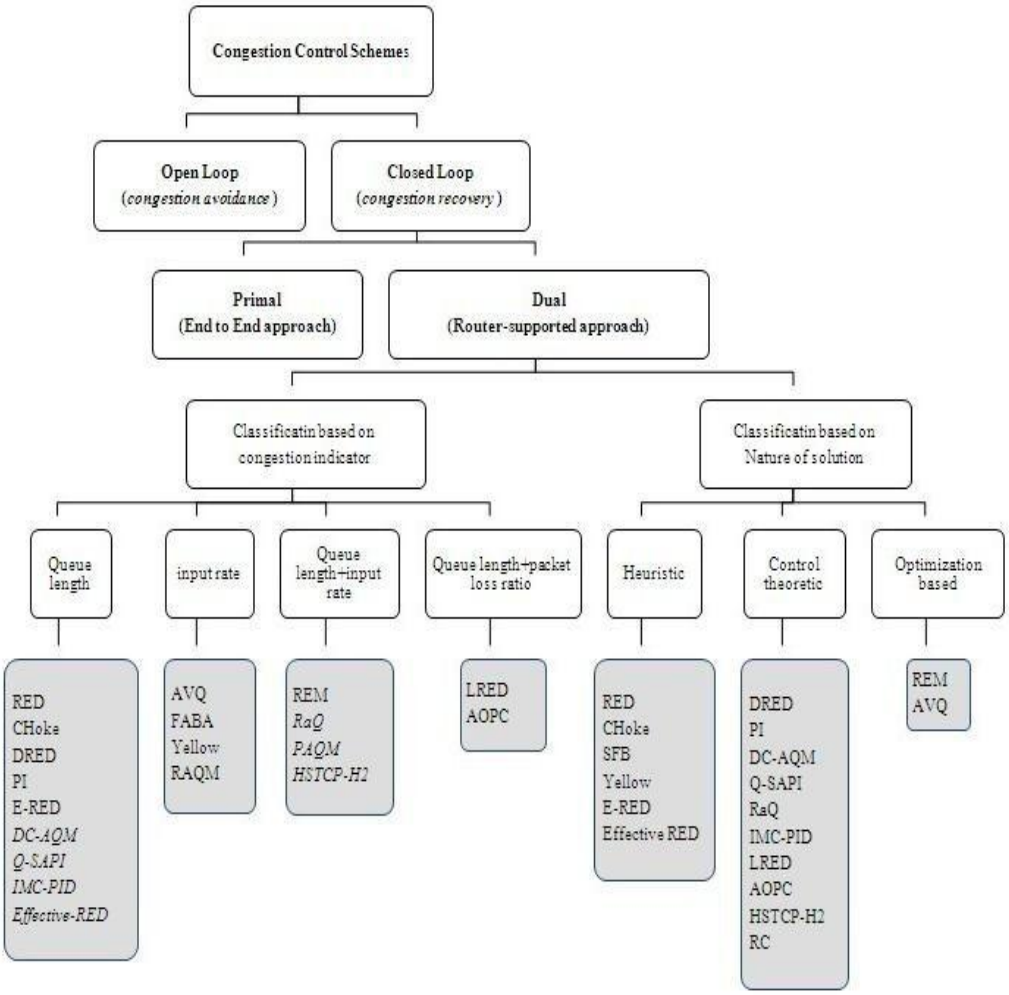


Figure 1 Flow of the TCP congestion control algorithm

VARIANTS OF TCP CONGESTION CONTROL ALGORITHMS

TCP is a very well know and time tested reliable transmission control protocol. But it is also required updating according to time and resources improvement.

TCP congestion control algorithms are classified according to their implementation of congestion control. These are broadly categorized through the Figure 2 with the congestion control approaches[11].



In most of the research it is observed that they are apply their algorithm on source based primal approach. In this category algorithms are classified in three main classes. Loss based, delay based and hybrid class. Some another classes also available as bandwidth estimation and signal sensing.

Loss Based Congestion Control Algorithms

These types of algorithms use the packet losses to signal for congestion window adjustment. The loss based congestion control algorithms not adjust the congestion window size when they received first packet loss, first count the number of packet losses occurs than after 2 or 3 packet losses identify and readjust the congestion windows size. The loss based congestion control algorithms are not in good categories because congestion control before it's happen is a good approach whereas loss based congestion control algorithms using the following strategies to implementation and controlling the congestion.

Slow Start

Additive increases the congestion window on receiving of successful acknowledgement.

Received packet losses than count ACKIf Fail ACK >2 or 3 then

Decrease the congestion window sudden or multiplicative.

Again increased congestion window when received successful ACK. This procedure continues going on tillthe connection termination or complete data transmitted.

There are number of TCP congestion control algorithms are implemented on the basis of loss based approach for examples TCP New Reno, STCP, HSTCP, BIC, CUBIC etc.

Delay Based Congestion Control Algorithms

These types of congestion control algorithms use the queuing delay time as a signal of the congestion window size adjustment. To implement of delay based congestion control algorithm we first know that the propagation delay. Propagation delay is also known as Round Trip Time (RTT). When ACK time limit cross the RTT than it is called Round Trip Time Out(RTO). This RTT and RTO is uses as signal of congestion window size adjustment. The RTT estimation is a challenging task in wireless communication because in wireless it having multiple elements like propagation delay, retransmission delay, heavy traffic increment links, access point queuing delay etc. the delay based congestion control algorithms implemented and tested as Fast TCP, Sync TCP etc.

Hybrid (Loss + Delay) Based congestion based algorithms

These algorithms use both packet loss as well as delay to adjusting the congestion window size. These algorithms works synchronously with packet loss and delay ACK. The algorithms first try to preventions network for congestion. If congestion occurred then resolve the congestion due to packet loss detection. In this categories the numbers of algorithms already implemented as TCP: Africa, Compound TCP , yeha TCP etc.

TCP CONGESTION CONTROL ALGORITHMS ANALYSIS AND REVIEW SUMMARY

The TCP is most widely used reliable data transmission protocol and it is implemented over 90% of internet traffic control but currently compound TCP algorithms is growing across the internet. Here we analysis of different types of

congestion control algorithms and review according to their strength. The table 1 specifies all details related to algorithm analysis and review study. We are going through numbers of algorithms and summarized the observation in the following table[12].

Table 1 Variants of TCP congestion control algorithms analysis and review result

TCP Protocol	**Approach**	**Features**
TCP New Reno	Loss Based	AIMD with factors function standardTCP Protocol
STCP (Scalable TCP)	Loss Based	MIMD Improving performance high speed network
HTCP (High speed long distance TCP)	Loss Based	AIMD with adaptive parameters for high speed and large delay
BIC (Binary Increase Congestion Control)	Loss Based	BIMD with slow start
CUBIC	Loss Based	Using Cubic window growth to improve the TCP for fast and long distance
Fast TCP	Delay Based	Equation based window adjusting
Sync TCP	Delay Based	Synchronization , adaptive queue delay based congestion window adjustment
TCP : Africa	Loss Based + Delay Based	Delay sensitive two mode congestion Control
Compound TCP	Loss Based + Delay Based	Add a scalable delay component intostandard TCP Reno for congestion Control
Yeha TCP	Loss Based + Delay Based	Use two mode fast and slow increments of congestion window
TCP Westwood+[13]	Loss Based + Bandwidth estimation	Based on logarithm increase function to high speed wireless environment
XCP[14]	Extra signaling	Smaller queue, higher throughput over wireless network

The basis of different research of TCP congestion control algorithms. We observed that the research are continuously going on to improvement of the TCP to achieve better throughput and minimum latency delay with utilization of maximum bandwidth of the communication channel. Further we will extend our analysis and review in term of the future direction of TCP congestion control research areas [11, 12, 15].

TCP RESEARCH DIRECTIONS

After studying the number of research articles we find out some interesting thing in future research direction. The TCP available for analysis and they provides their research results in different network scenarios. We can easy compare the future scope of the research and what will the problem till now having space to improvement. According to our analysis there are three four different research direction to make TCP better.

Improving TCP performance with large bandwidth.

Improving TCP performance over wireless network links.

Improving TCP for quality of real time applications over bottleneck communication link.

Some another research direction for TCP improvement are find out is suitable startup speed, exact bandwidth estimation, reduce latency time, fairness of shareable wireless link as well as controlling acknowledgement data packet for congestion control. These are the some few research direction for future development for congestion control.

CONCLUSION

In this research article we have reviewed and analysis of variants of TCP congestion control algorithms. Lots of modification work already done in the history of TCP congestion control. We focused in this paper TCP approaches and congestion windows controlling. How can TCP prevent congestion occurrence. If congestion occurs than what is the procedure worked with different TCP algorithms. Also reviewed carried out the TCP for wired and wireless approaches. In the future the main focus of TCP congestion control research is over the wireless link or mixed network. In this research paper we proposed some TCP congestion control research directions for the future. The main research direction is in TCP congestion control over wireless mobile network for high speed transmission low latency delay using the limited mobile resources. Another research area that we find out in this literature reviewed and analysis multiple startup speed of TCP depends on the criteria of the network.

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