1. Abstract

This paper gives some insights of the design of TCP. The motivation to design TCP is due to the congestion collapses. The objective is to make some mechanism such that the flows can obey a "conservation of packets" principle. The principle means that for a connection "in equilibrium", a new packet isn’t put into the network until an old packet leaves.

2. Contents

The design of TCP deal with the situations when packet conservation fails.

(1) The connection doesn’t get to equilibrium.

(2) A packet is injected before an old packet leaves.

(3) The equilibrium can’t be reached because of resource limits along the path.

The solutions are:

(1) Slow-start converges at the rate of \( R \log_2 W \), with round trip time \( R \) and window size \( W \). And at most twice the maximum source data will appear on the path.

(2) To keep the conservation, we should estimate the round trip time and set the timer correctly. Retransmission timer will be used to predict that the flow encounters congestion and the packet is dropped. The variation of \( R \) should be considered since the average of \( R \) and variation increase fast with the load \( \rho \), and scale like \((1 - \rho)^{-1}\). TCP use the low-pass filter \( R \leftarrow \alpha R + (1 - \alpha)M \), where \( R \) is the average rtt and \( M \) is the recent rtt. \( \alpha \) is a constant which is suggested to use 0.9.

(3) With good timers, we can have confidence that a timeout indicates a lost packet. We predict the congestion happens. The congestion avoidance strategy is to use multiplicative decrease of the window size. After the congestion, the window size is updated by additive increase.

3. Further Learning and Remarks

This paper suggest that gateway side of congestion control can be further explored. Only in gateways, at the convergence of flows, is there enough information to control sharing and fair allocation. Since the congestion grows exponentially, early detection in gateway level is also important.