Ideal Properties of Congestion Control Protocol
Ideal Properties of Congestion Control Protocol

We familiarize congestion control and discuss its ideal properties in this chapter. Since they are associated with congestion control continues be an energetic area of exploration for the past two and half a decade, we next briefly highlight the past developments in this field. Finally, we compare the congestion control methods that include the focus of this work.

3.1 Congestion Definition

The very first examine describe if we discuss congestion control will be the explanation of congestion. Traffic jam can be a view based on each user’s happiness as well as system fill. In the event that many of us solely consider the user’s satisfaction, we can think about the circumstance, the location where the user’s satisfaction diminishes on account of jealousy (for instance) and not on account of just about any adjustments throughout the products this assistance the consumer obtains. This specific can’t be considered as blockage. In the case everyone simply just looks at the system whole lot, blockage is only regarding system efficiency that could be almost any this means relating to blockage, still everyone declare that we have to look at the user’s satisfaction. We all will have to make note of in which network is on the system to satisfy owners. All of this means with regards to congestion may be:

**Definition 1 a multilevel can be considered to be stuffed from the standpoint of individual i, if the pleasure of i lowers as a result of changes from the characteristics of their network interconnection.**

A similar meaning was initially launched by simply Keshav (for any talk on this meaning notice [18]): “A network is said to be congested from the perspective of user i if the satisfaction of i decreases due to an *increase* in network load”. Our only 1 level connected with disagreement using Keshav is about this impact connected with network load.

They affirms which in turn just a good start interior community insert which in turn leads to getting some sort of loss throughout joy is often a indication connected with blockage, whilst all of us announce a change (increase in addition to decrease) interior community insert that includes a loss in joy is often a indicator connected with blockage.
Congestion cannot be removed completely but it can be avoided at maximum level. To avoid congestion at maximum level there should be any protocol or framework or mechanism which must possess the maximum ideal properties.

There are many properties in which we wish within a congestion control mechanism. These kinds of properties can easily spot in to a two different types:

i) Flow level and network properties and

ii) Qualities linked to ease of deployment and also difficulty associated with implementation.

3.2 Ideal Properties to Avoid Congestion

We make use of through this kind of area terms from the activity hypothesis and also microeconomics; all of us determine informally this term employed. A network gets to Nash equilibrium in the event, any time every single user works selfishly, no one can easily improve its fulfillment. The actual bandwidth allowance $A_i$ in the community will be Pareto maximum in case it doesn't occur a different bandwidth allowance $B$ such that all the user possess a fulfillment with $B$ increased or even the same compared to fulfillment with $a$, and one or more individual features a fulfillment with $B$ totally above the fulfillment with $a$. Many of us go over in the pursuing a couple of abstract components a best congestion control standard protocol should validate.

The properties are as follows:

Figure 3.1: Congestion definition example
3.2.1 Input Traffic Rate:

The input traffic rate $y_l(t)$ on link $l$ pertains to the sum giving rates involving runs moving past over the link. It shown as:

$$y_l(t) = \sum_{i \in I} x_i(t - D_{ii})$$

Where $i \in I$ is the number of flows moving through link $l$.

3.2.2 Link Capacity:

The proportions $C_l$ of link $l$ determines how fast the link can process or forward incoming packets of flows passing through the link.

3.2.3 Queue Length:

Any instantaneous increase in the input traffic rate compared to the link capacity causes queuing of packets. The instantaneous length of queue $q_l(t)$ at link $l$ is called queue length.

3.2.4 Efficiency:

Granted plenty of visitors’ requirements, any process should be able to keep near 100% link use all over numerous link sizes as well as round-trip instances. Associated with specific curiosity tend to be environments the spot that the per-flow bandwidth-delay item will be large. Really we're swiftly shifting to a good Internet exactly where tens as well as numerous Gbps end-to-end routes can be frequent.

This is confirmed by means of the fact that providers with Hong Kong (China) as well as The Japanese already are featuring 1 Gbps broadband providers to help systems [19].

3.2.5 Fairness:

The blockage manage must be able to commit the bandwidth of link in the sensible vogue. Numerous explanations of justness are provided in the literature [23]; the particular attentiveness
in this thesis is actually after RTT justness. RTT justness will allow for operates obtaining exclusive round-trip situations you can purchase similar throughput.

**3.2.6 Minimal Queuing Delay:**
If at all possible, a standard protocol needs to preserve lower typical queue time-span all the time. It is therefore due to the fact queued way upward packets improve latency for many streams.

**3.2.7 Average Flow Completion Times:**
The exact selection within apps signifies how the internet traffic includes flows together with a mix of move measurements. A protocol can gain completion times of flow superior than TCP. The particular completion of flow instances connected with quick transfers is usually sure by means of their particular round-trip times. As a result, the key to cut back their particular transport times is to slow up the queuing delay seasoned by means of these individuals, and this really is essential percentage of the RTT. Created for medium-sized and also for an extended time transfers, speedily achieving a superior throughput is major intended for minimizing their own motion conclude instances.

**3.2.8 Negligible Loss Rate:**
The protocol must encourage negligible losses because of barrier overflows. These losses cause retransmissions which in turn waste network bandwidth. Moreover, multitude of losses can produce system-level bottlenecks that will impression effectiveness. [6].

**3.2.9 Stability:**
Every time systems practical knowledge transient irregular conduct a result of fast raises within targeted traffic, the actual protocol can find this unique execute plus continue into a reputable operating place [23].
3.2.10 Strength to End-User Misinformation:

Essentially, virtually any method shouldn’t trust in honest facts inside the senders (e.g., round-trip conditions, traffic jam window sizes) to accomplish powerful just how this starts upwards brand-new strategies designed for destructive clients to help gain a advantage the system.

3.2.11 Easy to Deploy:

Deployment is definitely critical predicament that wills almost any smart blockage handle typical process wants to cope with. To get congestion handle standard protocol to complete effectively, the sender, the recipient, along with the routers down the route have to comply with the presumptions on the standard protocol. Changing most of these ingredients immediately can be a struggle. Ultimately, some sort of standard protocol ought to be responsive for you to deployment in this Internet architecture. By means of this particular many of us imply, it should certainly not demand modifications inside the IP header as well as the inclusion of any shim level, can easily coexist together with TCP without requiring difficult router-level systems, which enable it to become incrementally stationed without harming current standards within a significant means.

3.3 Ideal Congestion Control

As shown in Fig. 3.2, an ideal congestion control method should be efficient and fair. It should maintain high link utilization and ensure that all the flows are equally sharing the link capacity. It should try to maintain zero steady-state and transient packet loss rate to prevent unnecessary retransmissions. Additionally it is appealing which the method has fast convergence rate independent of link capacity and round-tip propagation delay. Another critical element of suitable congestion control technique should be to keep balance inside system without any oscillations in the sending rate of the flows.

Ideal Congestion Control
Figure 3.2 Behavior and properties of ideal congestion control

3.3.1 Feedback in Congestion Control

Congestion handle may be a closed-loop responses handle method, where by passes inside system respond to the congestion feedback in order to adjust their sending rates. Congestion feedback can be *implicit* in nature such as detections of loss of a packet or increase in RTT due to larger queuing delays. Congestion feedback can also be *explicit* in nature with the support from the routers. Explicit feedback can be single-bit in nature using the ECN bit [45] in TCP/IP headers or multi-bit in nature such as change in the congestion window [25], traffic load factor [52], link rate [51], desired sending rate [7], packet loss rate [55][76], and estimated fair rate [56][77].
3.3.2 The Big Picture

In 1983, the Internet moved to TCP/IP networking because of the many advantages associated with it. As documented in [39], Nagle observed congestion in the network as early as 1983. Since then and till today, congestion control remains an effective research area. In this vast period, many congestion control protocol have been suggested. As shown in Fig. 3.3, these congestion control protocols commonly divided in two different sections: a) End-to-End Congestion Control; b) Active Queue Management. They are briefly discussed in the following sections.

1. End-to-End Congestion Control

Over-crowding control strategies that do not really depend on routers and also make use of implied suggestions to be able to identify over-crowding tend to be termed end-to-end (E2E)
over-crowding control strategies. Many of the standard strategies on this classification tend to be revealed inside Fig.3.3 using TCP Reno being by far the most generally stationed from the Web. These methods are known to lack scalability [12] with the increase in either bandwidth or delay (or both) in the network. Hence, as shown in Fig. 2 many methods intended for high-speed networking include recently been offered. Some important include STCP [28], HSTCP [12], BIC-TCP [53], HTCP [31], FAST [22], [23], and LTCP [3]. Similar to TCP Reno, most of these methods are based on loss of packet as a sign congestion sign except the FAST that is based on increase in queuing delay or RTT. All of these protocols are based on end-to-end semantics and have only sender-side modifications. This facilitates their deployment in the Internet. In fact, most of these methods already have implementations that are part of the modern Linux kernel. A comparative experimental evaluation available in [32] shows that these methods are able to provide high link utilization. However, considering other performance metrics of an ideal congestion control algorithm they are only slightly better or even worse compared to TCP Reno.

2. Active Queue Management

AQM is a way of involving routers to aid the ETE congestion control methods. In AQM, a control algorithm runs at the routers that aims to provide more accurate and early congestion feedback to the end-hosts. As shown in Fig. 3.3, some of the proposed traditional AQM methods include PIC [18], [19], REM [2], RED [13], [14], and AVQ [29], [30]. Most of these methods either implicitly drop packets or mark the ECN bit [45] in the TCP/IP headers to provide early congestion warning. However, it has been shown in [35] using control theory that these methods are prone to instability as capacity or delay (or both) increases in the network. It has also been claimed that it is unlikely that any AQM scheme can operate in a stable manner over high-capacity and large-delay networks.

3.4 Summary:

In this chapter, we have defined ideal properties of congestion control. Many researcher works on different protocols to find out the best protocol based on ideal properties, but they found some have good fairness but less throughput, some has good throughput but non efficient fairness. The properties discussed in this chapter are ideal properties. Ideal congestion control is divided in behavior and properties. The efficient and fair behavior is required for ideal congestion control.
The properties needed for ideal congestion control have two parts one is zero transient loss and exponential coverage. Later Zero Steady state loss and control theoretic also the major properties for ideal congestion control. Congestion control is divided into End-to-End (E2E) and Active Queue Management (AQM) part. The division of congestion control implies the schemes are part of End-to-End schemes or Active Queue Management schemes for congestion control. Later End-to-End (E2E) are divided in Traditional and High-Speed Schemes and Active queue management (AQM) is also divided in Traditional and Explicit-Feedback. The schemes or protocols comes under traditional part of End-to-End (E2E) methodology are TCP-Tahoe, TCP-Reno, TCP-New Reno, TCP Vegas, TCP SACK and FACK. We try to cover all these protocols of End-to-End schemes in this thesis, later we also describe the properties of all these protocols or schemes, limitation of these schemes, design consideration of these schemes, performance of these schemes and also describe the properties they achieved in later chapters. We also describe the protocols or schemes of High-Speed part of End-to-End (E2E) schemes. We have look into the past development of protocols in this chapter. We conclude in this chapter the two fundamental questions for End-to-End congestion control:

1. The behavior of the sender at the time of occurrence of congestion
2. How the available capacity has been determine by the sender of the flow at any point of time.

The fundamental aspects for the sender is that, at the time of occurrence of congestion the flow should detect that congestion has been occurred and must try to reduce the rate of transmission, if flow do not reduce the rate of transmission then there is a situation of unstable state. In that case Network remains in unstable state. We also describe the algorithms of Active Queue management in this chapter.