Study on Different Mechanism for Congestion Control in Real Time Traffic for MANETS

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Abstract –During real time data transmission in MANET, the most promising issues include control of congestion at the network devices such as routers which have limited buffer capacity to hold incoming packets and forward them towards their respective destinations.This paper highlights on congestion control issues in real time environment as well as proposes different mechanism to prevent congestion in real time traffic .

Key Words: Open-loop control, Closed-loop control, Traffic shaping, End-to-end flow control

1. INTRODUCTION

In a packet switching network, packets are introduced in the nodes and the nodes in-turn forwards the packets into the network. When the “offered load” crosses certain limit, then there is a sharp fall in the throughput. This phenomenon is known as congestion. It affects queuing delay, packet loss or the blocking of new connections and also affects Quality of Service (QoS). QOS refers to the capability of network to provide better service to selected network traffic over various technologies.

Networks use congestion control and congestion avoidance techniques to try to avoid collapse. The process of managing the traffic flow inorder to control congestion is called congestion control. The two classes of congestion control are closed-loop control and open-loop control.

1.1 CLOSED-LOOP CONTROL

A closed-loop system is also referred as a feedback control system. These systems record the output instead of input and modify it according to the need. It generates preferred condition of the output as compared to the original one. It doesn’t encounter any external or internal disturbances. This mechanism tries to remove the congestion after it happens. A closed loop system has got the ability to perform accurately because of the feedback. Even under the presence of non linearity’s the system operates better than open loop system. But it is less stable compared to open loop system. Example: Pressure control system, speed control system, robot control system, temperature control system.

1.2 OPEN-LOOP CONTROL

An open-loop control system takes input under the consideration and does not react on the feedback to obtain the output. This is why it is also called a non-feedback control system. It has the ability to perform accurately, if its calibration is good. If the calibration is not perfect its performance will go down. In open-loop congestion control policies are used to prevent the congestion before it happens. If non-linearity are present the system operation is not good. In general it is more stable as the feedback is absent. Example: Traffic control system, control of furnace for coal heating, an electric washing machine.

2. LITERATURE SURVEY

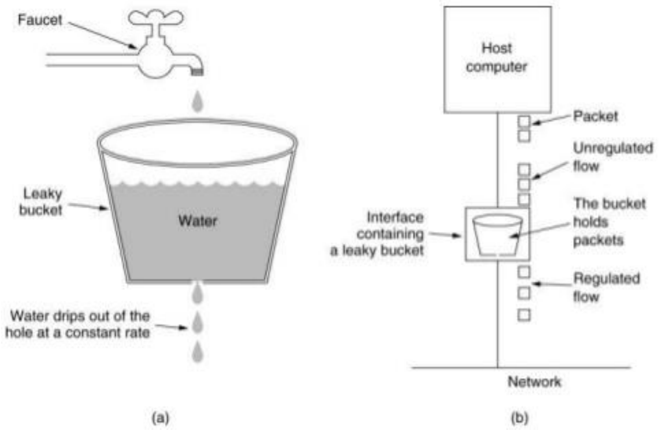
Panos Gevros, Jon Crowcroft, Peter Kirstein, and Saleem Bhatti proposed “Congestion Control Mechanisms and the Best Effort Service Model” In this article we revisit the best effort service model and the problem of congestion while focusing on the importance of cooperative resource sharing to the Internet’s success, and review the congestion control principles and mechanism which facilitate Internet resource sharing.

Mamata Rath, Umesh Prasad Rout, Niharika Pujari, Surendra Kumar Nanda and Sambhu Prasad Panda proposed “Congestion Control Mechanism for Real Time Traffic in Mobile Adhoc Networks” This paper highlights on congestion control issues in real time environment as well as proposes an upgraded traffic shaping mechanism in TCP/IP protocol suite of network model for real time applications with basic concept using the token bucket traffic shaping mechanism during packet routing at the intermediate nodes.

Mamata Rath, Binod Kumar Pattanayak proposed “Energy Competent Routing Protocol Design in MANET with Real time Application Provision” In this paper the authors have developed a robust and energy efficient routing protocol for MANET with real time support. Their approach is different as it calculates the remaining residual battery power, bounded delay and packet processing rate of the intermediate node before selecting a node to forward the packet in the direction of destination.

3. TRAFFIC SHAPING MECHANISM

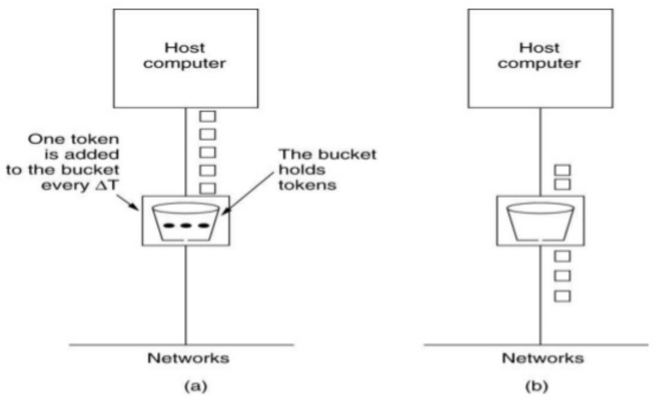
Traffic shaping is a technique for regulating the average rate and burstiness of a flow of data that enters the network. Traffic in data network is bursty-typically arrives at non-uniform rates as the traffic rate varies. When a flow is set up, the user and the network agree on a certain traffic pattern. Leaky bucket and token bucket algorithm make use of traffic shaping mechanism.



(a) A leaky bucket with water. (b) a leaky bucket with packets.

Fig: Leaky bucket

The leaky bucket is an algorithm based on an analogy of how a bucket with a leak will overflow if either the average rate at which the bucket leaks or if more water than the capacity of the bucket is poured in all at once, and how the water is from the bucket at a constant rate. It is used in packet switched computer networks and telecommunications networks in both the traffic policing and traffic shaping of data transmissions in the form of packets.



(a) Before (b) After

Fig: Token bucket

The token bucket is an algorithm used in packet switched computer networks and telecommunications networks. It can be used to check that data transmissions in the form of packets conform to define limits on bandwidth and burstiness. It can also be used as scheduling algorithm to determine the timing of transmissions that will comply with the limits set for the bandwidth and burstiness. I t is based on an analogy of a fixed capacity bucket into which tokens, normally representing a unit of bytes or a single packet of predetermined size, are added at a fixed rate.

4. THE PROBLEM OF CONGESTION

Congestion is the state of sustained network overload where the demand for network resources is close to or exceeds capacity. Network resources, namely link bandwidth and buffer space in the routers, are both finite and in many cases still expensive. The Internet has suffered from the problem of congestion which is inherent in best effort datagram networks due to uncoordinated resource sharing. It is possible for several IP packets to arrive at the router simultaneously, needing to be forwarded on the same output link. Clearly, not all of them can be forwarded simultaneously; there must be a service order. In the interim buffer space must be provided as temporary storage for the packets still awaiting transmission.

Sources that transmit simultaneously can create a demand for network resources (arrival rate) higher than the network can handle at a certain link. The buffer space in the routers offers a first level of protection against an increase in traffic arrival rate. However, if the situation persists, the buffer space is exhausted and the router has to start dropping packets. Traditionally Internet routers have used the first come first served (FCFS) service order, typically implemented by a first in first out (FIFO) queue, and drop from the tail at buffer overflow as their queue management strategy. The problem of congestion cannot be solved by introducing "infinite" buffer space inside the network; the queues would then grow without bound, and the end-to-end delay would increase. Moreover, when packet lifetime is finite, the packets coming out of the router would have timed out already and been retransmitted by the transport protocols[2].

5. CONGESTION CONTROL MECHANISMS

The Internet is decentralized by nature, comprising many heterogeneous administrative domains; therefore, resource management naturally involves both end-to-end as well as local (per-link) decisions. We identify two broad classes of congestion control mechanisms with regard to where these mechanisms are implemented: host-based and router-based mechanisms.

The entire Internet architecture was founded on the concept that all flow-related state should be kept on the hosts; therefore, the congestion control mechanisms were mainly implemented in the end hosts. Upon detection of congestion the sources should inject their packets into the network more slowly. This mechanism is called end-to-end flow control. In order for a host to be able to detect congestion, the routers must be able to provide the information that the network is currently (or is about to become) overloaded; this mechanism is called feedback. Flow control and feedback are conceptually related, so they are often referred to as feedback flow control. Although flow control should be aware of the feedback semantics, the exact mechanisms used to implement either are orthogonal, so we decided to treat them separately in our context. The feedback mechanism is distributed and can be implemented partly or entirely at the end hosts (receiver side) or routers. Packet drops were, and to a great extent are still, the only means for a router to fight congestion. The sources become aware of the packet drops, interpret them as a congestion indication, and reduce their rates.

The feedback from the network and the response from the source are the foundations of Internet congestion control and are very important because they facilitate decentralized resource allocation. However, with decisions made at the end hosts and treatment of the network as a black box that simply drops packets, there is clearly a limit on how much control can be achieved over the allocation of network resources. This also limits the range of services the network is capable of offering. Routers, on the other hand, know exactly how congested they are and can therefore perform more drastic resource management. Thus, the introduction of router mechanisms for congestion control that will enable the network to more actively manage its own resources seems inescapable. These mechanisms can be used as building blocks for providing higher-level resource management mechanisms such as link sharing, penalty boxes, and pricing, which by means of financial incentives controls the sharing of network resources.

The extension of router functionality per se does not contradict the design philosophy of the Internet where all state should be kept at the end hosts or, better, at the edges of the network. Routers have two conceptually orthogonal methods of managing their own resources: scheduling to directly manage bandwidth allocation on an output link, and queue/buffer management to manage buffer space and queue occupancy, respectively, and thus indirectly affecting bandwidth allocation [2].

6. CONGESTION CONTROL PHASES

Clearly congestion can be avoided at the expense of low resource utilization; however, this is usually undesirable. Thus, the goal of any congestion control mechanism, with respect to resource utilization, is to operate the resource (link) in a region close to its capacity .There are two phases in congestion control:

• Congestion avoidance when the system operates about the Knee.

• Congestion recovery (often confusingly referred to as congestion control in the literature) when the state of the system is between the knee and the cliff, and congestion has occurred so that the total load should be decreased to avoid collapse. We next treat in turn each of the four classes of congestion control mechanisms identified above [2].

7. END-TO-END FLOW CONTROL

In control theory a controller changes its input to a black box and observes the corresponding output. The goal is to choose the input as a function of the observed output so that the system state conforms to some desired objective, provided that the system state can be observed. From a control-theoretic viewpoint the end host flow adjustment is the response to a servo-control loop which needs to match the source's sending rate to the rate that corresponds to its fair share at the bottleneck link. The problem is that the appropriate bottleneck service rate becomes known to the source after a delay, and the new rate (after any adjustments) takes effect at the bottleneck only after another delay. The precision of the servo-control loop determines performance; if the queue at the bottleneck link is empty, throughput will be less than the maximum. If there are always packets in the queue, the link will never be idle, but if the queue size grows beyond a limit, packets will start being discarded. However, in flow control, the output of the system (the rate of a flow as seen at the receiver) does not depend only on the actions of that particular flow, but also on the actions of all other flows sharing the same path.

Open-loop flow control is acceptable only in an environment without considerations about the impact of individual actions to other network users. In an open-loop flow control scheme the sender describes its rate to the network with parameters like burst size and interburst interval. Simply stating the rate is not sufficient because b packets/s may be 1 packet every 1/b s, but it can also mean a burst of b back-to-back packets every second, which might be unacceptable for a gateway that does not have enough buffer space to store the burst. The network examines the parameters given by the sender and if the request can be granted (admission control based on availability or policy criteria) it reserves resources, corresponding to these parameters, along the path from the sender to the receiver. The sender simply ensures that its rate conforms to the given description, and in this fashion network congestion is avoided. This paradigm fits nicely in a connection- oriented architecture like IntServ but cannot be enforced only with end-to-end mechanisms; it requires resource management mechanisms in all the routers.

Closed-loop flow control schemes target more dynamic network environments where it is a requirement for the sources to dynamically adapt their rate to match their fair share of network resources. The fair share usually fluctuates, and the sender must be able to track these changes and adjust its rate to allow for more efficient resource utilization. Closed-loop schemes can be adaptive window, in which the source indirectly controls the transmission rate by modifying the number of packets sent but not yet acknowledged (window), or adaptive rate, in which the source, every time it sends a packet, sets a timer with a timeout value equal to the inverse of the appropriate transmission rate and transmits the next packet when the timer expires. The potential damage to the network is constrained in different ways, but window-based schemes are easier to implement because they do not require a fine-grained timer, which is hard to implement in non-real-time operating systems. If a closed-loop flow control scheme appears ineffective, either the sources suffer from excessive packet loss or the network resources are underutilized [2].

8. FEEDBACK MECHANISMS

The mechanism used for notifying the sender about network congestion or the appropriate sending rate is called the feedback, and inherently involves both the routers that generate the congestion signals and the receiver host(s) that propagates the signal to the sender for interpreting it accordingly.[2] Closed loop flow control mechanisms and overall network performance rely heavily on feedback. Without a feedback mechanism a source would be clueless as to what to do with its sending rate, and the network could become unstable, unfair, and either congested or underutilized. Feedback involves information about the state of the system, so in principle it should originate from the network and ultimately be delivered to the sender. The sender receives feedback either directly from the network or from the network via the receiver; therefore, there are two forms of feedback: implicit or explicit.

8.1 IMPLICIT FEEDBACK

Implicit feedback requires the end-hosts to be responsible for monitoring the performance of their own transmissions (delay, loss) for indications that will let them infer the state of the network and determine their appropriate sending rate. Nevertheless, it is debatable how accurately this can be derived. The most common form of implicit feedback signal is packet drop and has been traditionally used by Internet routers. However, packet drop is not necessarily an indication of congestion, for instance in error prone wireless links. Another proposed method of implicit feedback is the observation of the rate at which packets emerge from the bottleneck or the measurement of the change in end-to-end delay as the transmission rate changes.

The advantage of implicit feedback is simplicity in the routers; routers are left to focus only on resource allocation, and do not have to calculate and produce an appropriate feedback signal. However, the scheduling mechanisms must be known to the end hosts for implicit feedback to be useful; otherwise, the observed performance may be misleading and not accurately describe the actual congestion state of the network. For example, with FIFO scheduling an increase in the rate may lead to an increase in the observed throughput, although queues may have already started building up and the total delay has increased [2].

8.2 EXPLICIT FEEDBACK

In principle explicit feedback can be in the form of congestion notification or rate indication. Due to the limitations in the information that can be carried in protocol headers explicit feedback can be binary or multivalued (usually limited to a small number of values: "how much congestion has been experienced"). In the case of binary feedback the appropriate operating point is found through an iteration process of network feedback and host adjustments. For explicit feedback the only methods proposed for TCP/IP networks is the ICMP Source Quench messages and Explicit Congestion Notification (ECN) proposal. The ICMP Source Quench message is sent by the IP layer of a host or router to throttle back a sender in case the host/router runs out of buffers or throws datagram away ICMP Source Quench is very rarely used in the Internet, and although there is no substantial evidence, the current feeling is to deprecate this message because it consumes bandwidth at times of congestion, and is generally an ineffective and unfair fix to congestion . In the ECN feedback scheme the router sets a bit in the packet header (CE bit) whenever it detects incipient congestion. The receiver copies this bit into the header of the acknowledgment packet, and the flow control mechanism at the sender is responsible for adjusting the window (or rate) based on a certain algorithm. The algorithms used for congestion detection and window adjustment as responses to explicit feedback are part of the queue management and flow control mechanisms, respectively. Explicit feedback implies an extra mechanism in the router, but on the other hand provides more quantitative control information which can be valuable for the adjustment process. Explicit rate indication is another method of explicit feedback in which the switches perform rate allocation and the calculated rates are explicitly communicated back to the sources (via the receiver) as information in the packet headers; it has been used in ATM networks but not in the Internet [2].

9. CONCLUSION

Best effort service has been tremendously successful for data traffic, which today accounts for the vast majority of Internet traffic; there are no indications that this will stop being the case in the future. The main reason for pursuing QoS was concerns about the requirements of emerging real-time and streaming multimedia applications, which could not be met in the existing service model. Nevertheless, it has been amply demonstrated that many popular applications (packet audio, videoconferencing) are able to adapt to dynamic network conditions by changing their transmission rate using different coding techniques, and therefore perform sufficiently well under moderate congestion levels. Thus, it is likely for the Internet to evolve toward a best effort network which, if controlled and provisioned appropriately, will be able to satisfy the majority of popular applications that are willing to tolerate service deterioration due to transient congestion. This could sustain a large market for best effort service and would limit the applicability of service models for guaranteed QoS to corporate intranets and virtual private networks. Most of the congestion control mechanisms presented in this article, the router-based ones in particular, were almost exclusively studied in the context of guaranteed QoS and real time traffic. There has been considerably less research in their use within the best effort service framework, so there is a widespread misconception that the best effort service model necessarily implies simple FIFO queues in the routers. If appropriately used these mechanisms could provide, for instance, preferentially lower delays to "fragile" interactive applications (like telnet) without striving to provide any quantitative QoS guarantees. The authors believe that their use can considerably improve, enhance, and protect the best effort service model and that therefore this is a direction which deserves further investigation [2].

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