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Congestion Control in Mobile Adhoc Network

Vandana
Department of Computer Science and Engineering
Galaxy Global Group of Institutions, Dinarpur
Ambala, Haryana, India

Er. Saurabh Mittal
Associate Prof. & HOD, Department of CSE,
Galaxy Global Group of Institutions, Dinarpur
Ambala, Haryana, India

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Abstract: When compared to wired-based networks Wireless networks are spreading very fast because it is very easy to install, lower cost, reduced dependence on infrastructure and support for emerging mobile and sensing applications. But, wireless channels cannot carry much of data efficiently. When one part of the subnet becomes overloaded, congestions results. Because routers are receiving packet faster than they can forward them, that's why one of the two must happen. Several techniques can be employed for congestion control. In other words when too much traffic is offered, congestion sets in and performance degrades sharply. Congestion Control refers to techniques and mechanisms that can either prevent congestion, before it happens, or remove congestion, after it has happened. Congestion control mechanisms are categorized into two categories, one category prevents the congestion from happening and the other category removes congestion after it has taken place. If the broadcast rate of (TCP) transmission control protocol does not match that of the medium access control (MAC) protocol in wireless ad hoc networks, it causes network congestion and network performance degradation.

Keywords: Congestion, Congestion control, Proactive and reactive control, Advantages and disadvantages of proactive &reactive control

I. INTRODUCTION

1.1 Congestion

When the number of packets extraordinary exceeds the limit that can be handled by the network resources, the network performance degrades, and this situation is called congestion. Congestion simply means excess numbers or blockage due to overcapacity .It is similar to traffic jam caused by many cars on a narrow road[1] .A network that is congested from the perspective of one user is not necessarily congested from the perspective of another.

1.2 Congestion control

Two styles of control, proactive and reactive control, are presented. It is shown that congestion control must happen at several different time scales.

1.2.1 Proactive and reactive control

Congestion is the loss of utility to a user due to an increase in the network load. Hence congestion control is defined to be the set of mechanisms that avoid or decrease such deterioration. Practically speaking, a network can be said to control congestion if it provides each user with mechanisms to denote and achieve utility from the network. For example, if some user desires low queuing delays, then the system should provide a mechanism that allows the user to achieve this objective. If the network is not capable to prevent a loss of utility to a user, then it should try to limit the loss to the extent possible, and, further, it should try to be fair to all the affected parties. Thus, in reservation less networks, where a defeat of utility at high loads is unavoidable, we are concerned not only with the extent to which utility is lost, but also the degree to which the loss of utility is fairly circulated to the affected users. A network can provide service in one of two ways. First, it can request that each user specify a performance requirement, and can reserve resources so that this level of performance is always presented to the user. This is proactive or reservation-oriented congestion control. Alternatively, users can be allowed to send data without reserving resources, but with the prospect that, if the network is heavily loaded, they may receive low utility from the network. The second method is applicable in reservation less networks. In this case, users must adjust to changes in the network state, and congestion control refers to ways in which a network can allow users to detect changes in network state, and corresponding mechanisms that settle in the user's flow to changes in this state. In a proactive scheme, the congestion control mechanism is to make reservations of network resources so that resource availability is deterministically certain to admit conversations. In a reactive scheme the owners of conversations need to monitor and react to changes in network state to avert congestion

1.2.2 Advantages and disadvantages of proactive &reactive control.

Proactive control

Users can be guaranteed that they will never experience loss of utility. On the other hand, to be able to make this guarantee, the number of users has to be restricted, and this could lead to underutilization of the network.

Reactive control

It allows much more flexibility in the allocation of resources. Since users are typically not guaranteed a level of utility by the network, resources can be statistically multiplexed.

However, there is always a chance that correlated traffic bursts will overload the network, causing performance degradation, and hence, congestion. It is important to realize that proactive and reactive controls are not mutually exclusive. Hybrid schemes can combine

aspects of both approaches. One such hybrid scheme is for the network to provide statistical guarantees. For example, a user could be guaranteed an end to end delay of less than 10 seconds with 0.9 probabilities. Such numerical guarantees allow a network administrator to overbook resources in a controlled manner. Thus, statistical multiplexing gains are achieved, but without absolutely giving up performance guarantees. Another hybrid scheme is for the network to support two types of users: Guaranteed service users and Best-effort users. Guaranteed service (GS) Users are given a assurance of quality of service, and resources are reserved for them. Best-effort (BE)Users are not given guarantees and they use up whatever resources are left unutilized by GS users. Finally, a server may reserve some minimum amount of resources for each user. Since every user has some reservation, some minimum utility is guaranteed. At times of heavy load, users compete for resources kept in a common pool. Assuming some degree of independence of traffic, statistical multiplexing can be achieved without the possibility of a complete loss of utility.

1.3 Need for congestion control in networks

Congestion is a severe problem in current reservation less networks. However, in networks the available bandwidths and switching speeds will be several orders of magnitude larger.

1.4 Why should congestion arise in such networks?

There are several reasons:-

Large bandwidth-delay product

The service rate of a circuit multiplied by the round trip time determines the amount of data that a conversation must have outstanding in order to fully utilize the network. The round trip time is bounded from below by the speed-of-light propagation delay through the network. Hence, as the raw trunk bandwidth and the service rate of a conversation increases, so does the amount of outstanding data per conversation.

1.5 Fundamental requirements of a congestion control scheme

These are 7

1. Efficiency
2. Ability to deal with heterogeneity
3. Ability to deal with ill-behaved sources
4. Stability
5. Scalability
6. Simplicity
7. Fairness

1.5.1 Efficiency

There are two aspects to efficiency. First, how much overhead does the congestion control scheme impose upon the network? As an extreme example, control packets such as the Source Quench packets in TCP/IP themselves overload the congested network. We would like a control scheme to impose a minimal additional burden upon the network.

1.5.2. Heterogeneity

As networks enhance in scale and coverage, they span a range of hardware and software architectures. A control scheme that assumes a single packet size, a single transport layer protocol or a single type of service cannot be successful in such an environment. Thus, we want the control scheme to be implementable on a wide range of network architectures.

1.5.3. Ability to deal with misbehaving sources

Note that in current networks, a network administrator does not have administrative control over the sources of messages. Thus, sources (such as users of personal workstations) are free to manipulate the network protocols to maximize the utility that they get from the network.

1.6 Fundamental assumptions

Underlying any congestion control scheme are some implicit assumptions about the network environment. These unstated assumptions largely determine the nature of the control scheme and its performance limits. We consider some of these assumptions in this section.

Administrative control

Some schemes assume that we can control sources but not switches e.g. Others assume that we can control both the sources and the switches Still others assume complete control over the switches, and the ability to monitor source traffic, but no control over source traffic . This assumption should be constrained by reality.

1.7 Techniques used to manage congestion control

The basic techniques may be used to manage congestion.

End-system flow control: This is not a congestion control scheme, but a way to avoid the sender from overrunning the buffers of the receiver.

Network congestion control: In this scheme, end systems throttle back in order to avoid congesting the network. The mechanism is similar to end-to-end flow controls, but the purpose is to reduce congestion in the network, not the receiver [2].

II. RELATED WORK

The research work performed in this area by different researchers is presented as follows:

Qiao-Yan Kang *et al.* [1] shows with the increasing popularity of various multicast applications, the application of existing multicast congestion control mechanisms to wireless networks, which were planned for wired networks, is a challenging work due to high bit error rate, fading and handover. we proposed an expert-control-based multicast congestion control mechanism for wireless networks, named ECBMCC. In this novel mechanism, multicast receivers sent their feedback information fto the expert controller rather than the sender, and the expert controller made sure the status of TCP connection by inferring according to the feedback information. With the help of expert inference, ECBMCC easily differentiated between wireless link error and network congestion, and select the accurate congestion control policy to control the sending rate. And ECBMCC avoided the problem of feedback implosion, thus enhanced the scalability of multicast congestion control mechanism. The simulation outcome show that this mechanism can strengthen the congestion and random errors processing capability in real time and develop the network throughput, and this control scheme is more robust than existing mechanisms and more scalable

Ohsaki , H. *et al.*[2]states that a window-based flow control mechanism is a sort of feedback-based congestion control mechanisms, and has been usually used in current TCPLP networks. Recently proposed TCP Vegas is another version of the TCP mechanism and has potential to attain much better performance than current TCP Tahoe and Reno. However, it has not been fully investigated how to determine control parameters of TCP Vegas and focus on a window-based flow control mechanism relayed on a congestion avoidance mechanism of TCP Vegas present a control theoretic analysis for its stability. Then discuss several drawbacks of the window-based flow control mechanism, being inherited from TCP Vegas, during simulation experiments. Finally investigate how these drawbacks are solved by incorporating the ECN (Explicit Congestion Notification) mechanism into the window-based flow control mechanism.

Kai Shi *et al*.[3] proposed a point-to-point MAC layer congestion control Mechanism (MACC) in IEEE 802.11 WLANs. First examine the reasons of wired congestion and wireless congestion in TCP and mainly study the latter which TCP could not solve well. Then aiming to alleviate this type of congestion of TCP in WLANs, get the concept of congestion control into MAC layer and propose MACC. The main idea of MACC is using the congestion window to control the sending rate in MAC layer. Being Different from congestion control in TCP which is through dipping the sending rate, MACC controls the congestion through increasing the channel utilization and improving the fairness. Simulation results in diverse scenarios demonstrate that the performances of network throughput and fairness are improved considerably and also TCP congestion is alleviated much by using MACC.

N.Hirzaika *et al.*[4] mention that during the past few years, the study of internetworking systems has been a very active research area. There is an increasing need for novel protocol mechanisms capable of ensuring proper interwork operation for high-speed systems. These systems consist of a high-speed network which internetworks a few low-speed LANs. Proper coupling of sub networks having a large difference in transmission speeds has been identified as one of the major challenges to overcome and propose a novel congestion control mechanism, specially designed for high-speed internetwork systems. The design of this control mechanism is done, by keeping in mind that a fair and simple control mechanism is necessary when dealing with high-speed communications systems. A performance evaluation of this mechanism is carried.

Jing Zhao et al.[5]states that Congestion has always been a serious problem for all kinds of communication networks. Wireless sensor networks (WSN) face unique difficulties in dealing with congestion due to their unique requirements and constraints. Various congestion control schemes for WSN have been projected recently. These schemes try to solve the problem either at the MAC layer or through a cross-layer approach. This paper explores these schemes and tries to find their common features, which may direct future research.

Parminder Kaur et al. [6] Transmission Control Protocol (TCP) is a reliable, end-to-end transport protocol, which is most widely used for data services and is very competent for wired networks. However, experiments and research showed that TCP's congestion control algorithm performs very poorly over Wireless Ad Hoc Networks with degraded throughputs and harsh unfairness among flows. In this paper, a deep study has been conducted in order to study the factors that cause congestion in an ad hoc wireless network. Main center in this report has been to simulate and study the effect of change in topology and number of users on network congestion. Apart from that, the effects of network congestion and the significance of its study have also been highlighted. Congestion is a critical factor, in determining the quality of network. It also determines the dependability and sustainability of a network. Deploying new network infrastructure to tackle congestion problem is not inexpensively viable solution, hence it is important to understand the reasons behind such network operation conditions and then design apposite methods to overcome them. In this paper, various network behaviors' have been simulated using OPNET Modeler 14.5 to study how node's buffer space gives contact to the in-flight packets in ad hoc environment by also taking mobility and power consumption into consideration. With a controlled size of users ( ) the network condition has been simulated. Performance has been measure on some parameters such as throughput, number of packets dropped, and retransmission count and end number of users changed**.**

Alhamali Masoud Alfrgani et al.[7]Congestion control in wireless networks has been expansively investigated over the years and several schemes and techniques have been developed, all with the aim of improving performance in wireless net-work. With the quick expansion and implementation of wireless technology it is essential that the congestion control problem be solved. This paper presents a congestion control schemes which are dissimilar in slow start threshold calculation, bandwidth estimation, and congestion window manipulation. A comprehensive comparison of these approaches is given in relation to assumptions, bandwidth estimation, congestion window size manipulation, performance assessment, fairness and friendliness and improved throughput.

Anju et al.[8] An ad-hoc wireless network is a collection of wireless devices which for transitory network without the aid of any established infrastructure or centralized administration. Although traffic control seems to be an effective method for controlling congestion, it suggests a number of drawbacks which are not easy to ignore. The most important drawback steams from the fact that higher traffic load occurs when the monitored event takes place. At this instance there is a higher probability of congestion happening in the network. "Congestion Control" is a mechanism which assures that resources are used optimally & the system has maximum throughput for the given condition. The main plan of the congestion control is to assure that system is running at its rated capacity even in worst condition (overload situation). By calculating the rate with which packets are injected in the network, the amount of information that reaches the data sinks reduces. This fact can jeopardize the purpose of the network. Moreover, network connectivity issues occur since in most cases, this approach utilizes the shortest path from source to sink. Thus, in case of heavy data load, this path of nodes can easily become power exhausted. To accomplish this, we take advantage of the fact that mobile nodes are frequently redundantly and/or densely deployed. In this thesis, we focus on congestion detection and avoid the congestion using Ad hoc on demand routing protocol (AODV) using MATLAB.

III. PROPOSED WORK

3.1 Problem Formulation

Solving Congestion control problem in wireless network is required when maximum number of nodes and data are used in network. By solving Congestion control problem and the performance of Network will increase reduction in traffic and response time.

3.2 Proposed Work

If the number of flows a router would have to handle is fixed at the factory, routers could be shipped with parameters set to achieve a reasonable tradeoff between loss rate and queuing delay. An ideal router would automatically adapt its queuing configuration to the load. This problem divides into three parts. First, a mechanism to count active flows. Second a option of target queue length and drop rate based on the flow count.Third a mechanism to enforce the targets on a FIFO queue.

IV. RESULTS AND ANALYSIS

Evaluation of congestion control mechanisms in wireless network will be done on various network parameter such as varying queue length and number of sender increased through simulation.

Performance Metrics

In analyzing a MANET routing protocol different statistics or performance metrics are used. In this subsection, discuss the necessary metrics required to evaluate performance that are.

a) Network throughput
b) End to end delay

Network throughput

A network throughput gives the average rate at which message is successfully delivered among a receiver (destination node) and its sender (source node).

End-to-end delay

Thus, the end-to-end delay of packets is the total amount of delays encountered in the entire network at every hop going to its destination. In MANETs, this type of delay is usually caused by certain connection tearing or/and the signal strength among nodes been low, or some congestion. The consistency of a routing protocol can be determined by its end-to-end delay on a network.

Packet delivery ratio

This is one more performance metric that is used to find out the efficiency and accuracy of MANET's routing protocol because it is used to determine the rate of loosing packets. Similar to the network throughput, packet delivery ratio (PDR) is probable to be high.

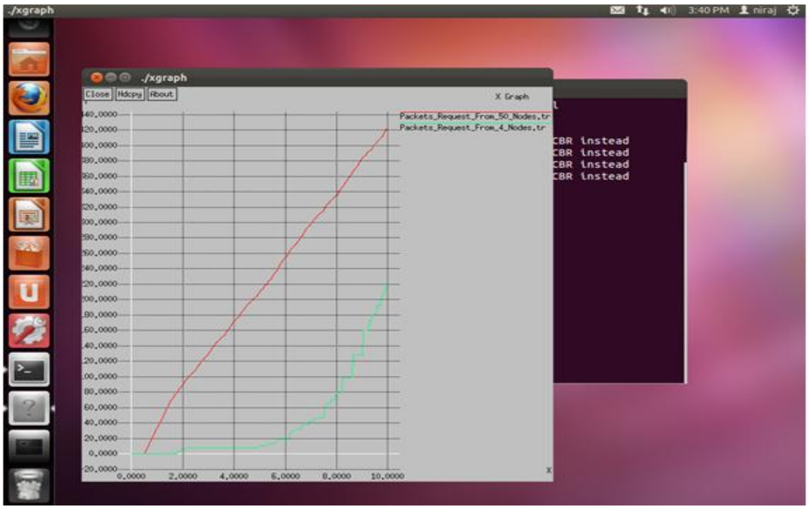

Figure 4.1 performance of congestion control mechanism

Here no. of packets per sender is 70 packets, and maximum permitted senders are 4.1 There- for maximum no. of packets that can be buffered in queue is 280. Figure 4 gives the simulation results. Here red line shows buffering request from 50 senders is impending to maximum size of approximately 420 packets. This is because of no congestion control method is applied. Green line gives buffering request from 4 senders is approaching to maximum size of approximately 220 packets, which is less compared to buffering capability of queue (280 packets in our case). The result shows a method to count active flows, target queue length and fall rate to impose the targets on a FIFO queue.

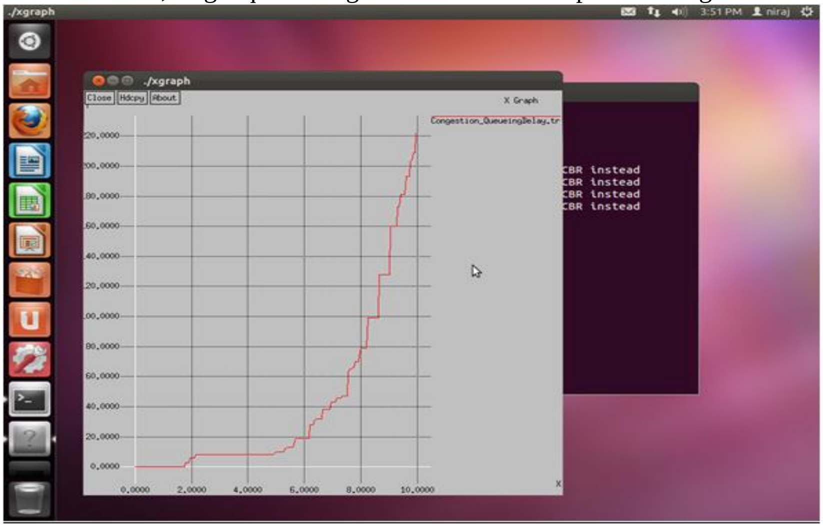

Figure 4.2 Queuing Delay

Figure 4.2 shows result of Queuing delay Maximum goes to 220 packets, if no congestion control method is applied. When all the 50 nodes are allowed to send packets, due to fixed buffering capacity of the queue (280 packets) left over 220 packets can't be enforced on queue. This buffering delay shows congested network.

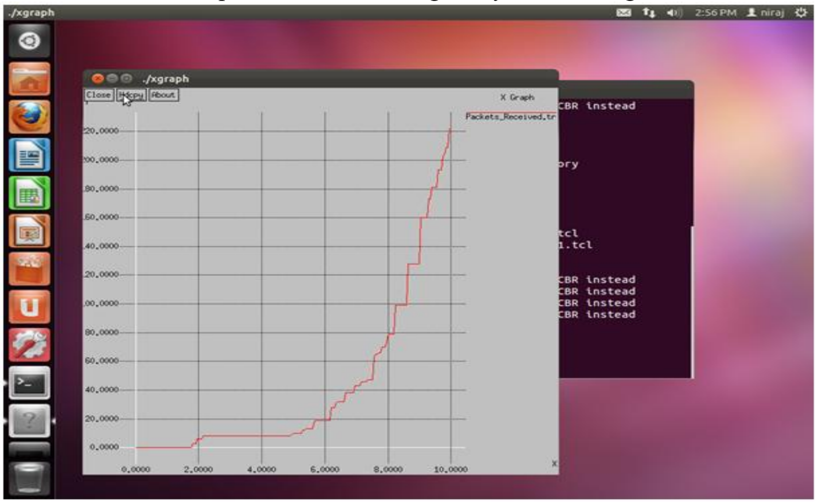

Figure 4.3 Packets Received With congestion control mechanism

Figure 4.3 shows the total numbers of packets received from all the active senders. Here, the packets requested is 220 and packets received is also 220. Hence,there is no packet loss in this approach.

V. CONCLUSION AND FUTURE SCOPE

Congestion loss in bust networks depends on the number of active flows and the total storage in the network. Total storage included both router buffer memory and packets in flight on long links. In this thesis a simple flow counting algorithm is presented. The algorithm takes a few instructions per sender and uses one bit of state per flow. The algorithm provides congestion feedback by varying the number of packets per sender in proportion to the queue length. This approach has the desirable effect of reducing queuing delay, however it produces high loss rate as the number of flows increases, causing long and unfair timeout delays.

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