Analysis of Congestion using mobile nodes in Wireless Network

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Abstract

This article discusses the work plan of wireless ad hoc network and the problems related to it during congestion. The congestion in wireless network congestion will vary with different topologies, methods of network deployment, mobility, channel utilization and power consumption at node level. This might lead to degradation of TCP performance of packet loss. In this research the proposed work plan the use of different number of nodes and their effect on congestion in wireless network. The reason for loss in wireless network could be overload of packets in node buffer space. This research will also enable us to conduct a deeper study to understand network congestion in ad-hoc networks. We will try to simulate various network environments with different number of users and then study the network on parameters like throughput, good put; packets dropped etc.

Keywords - Wireless; OPNET; TCP; congestion; buffer size; CBR; PLI; AD-HOC ; NODES.

I. INTRODUCTION

These Days, Wireless is an alternative advanced technology that plays an important role to convey shared information among users wherever there is limited by distance and cost. The wireless network is of two types the infrastructure network and the Ad-hoc network [5]. An ad-hoc network is made up of multiple "nodes" connected by "links". Links are influenced by the node's resources (e.g. transmitter power, computing power and memory) and by behavioral properties (e.g. reliability), as well as by link properties (e.g. length-of-link and signal loss, interference and noise). These networks provide mobile users with ubiquitous computing capability and information access regardless of the users' location [6]. It supports anytime and anywhere computing and helps in formation and deformation of mobile networks.

In this study, the paper goal is to study the packet behavior in wireless network. This will be demonstrated on a small group of users which the size of users is given as a formula, 2^n where n=0, 1, 2, 3 and 4. A simulation study is carried out with OPNET Modeler 14.5 [3].

This figure 1 shows the wireless Ad –Hoc network with a wireless router connecting two wireless computer.

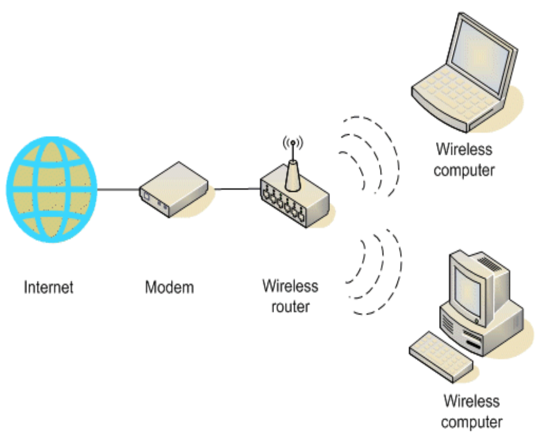


Figure 1. Ad-hoc Network

However, the communication over wireless environment still faces its own challenges [1, 2] such as:

- High Bit Error Rate (BER)

- Mobility
- Power / Energy consumption
- Channel Contention
- Topology Changes

These problems contribute to packet drop or packet reordering in wireless network. To overcome this problem some standards like congestion control mechanisms or congestion avoidance can be used. The number of users can affect the traffic in wireless network. In wireless networks, the congestion control protocols and methods are very different from the conventional wired networks. Specially, in the case of ad-hoc networks it is hard to control network congestion, as every node behaves like a router.

This paper further discusses the problems in wireless network and the solutions like congestion avoidance and prevention mechanism. The section 3 discusses the methodology flowchart is explained and how it works with number of users, topology.

The simulator OPNET 14.5 is used to show the results and carry out the simulation. OPNET is originally built for the simulation of fixed networks [3]. OPNET can be used as a research tool or as a network design/analysis tool (end-user).

II. BACKGROUND STUDY

A. Wireless Infrastructure

Basically, there are two types of Wireless Infrastructure: Ad hoc mode and Infrastructure mode. The former form allows nodes to be connected without Access Point. Each nodes act as a router and forward packet until arrived at the destination. MANET and Vehicular Ad hoc are examples for ad hoc wireless network.

The latter form uses an Access Point to divert packets transmission among wireless nodes. WLAN, Cellular Network and Satellite Network shares common feature in order to communication each others.

B. TCP Congestion Control

The TCP protocol incorporates sender receiver flow control through acknowledgements being sent, from the destination to the source node, for the packets received. Using these acknowledgement packets, the congestion control mechanism operates as follows: The source TCP uses a Window parameter which is the maximum number of unacknowledged packets that it can have at any given time during the connection. This restricts the maximum number of packets that the sender can offer to the network without having received the acknowledgement for any of them.

Adaptive Window Control involves adaptively changing the size of the transmission window based on the acknowledgement packets that the source has received [6].

C. Congestion Control in Wireless

The initial Congestion Control mechanism was invented for TCP traffics in wired environment. When wireless start deployed widely in communication world, this mechanism has been adjusted to handle congestion problem which also occurred in wireless. The weakness of TCP Congestion Control obviously appeared when the TCP Reno fails to react effectively in wireless [16]. To overcome this weakness, the congestion avoidance phase has been enhanced by identifying the potential types of packet losses before deciding the possible action to be taken. This approach is called as Packet Loss Identification (PLI) [7, 8].

Implementation of PLI can be categorized into three types [9] which are Single Metric-based, Multiple Metric-based and Inference-based. Common metrics used such as round trip time (RTT), inter-arrival time, jitter, congestion window, average loss ratio and others. In some cases, a small packet has been created as additional information during data transmission. To have more accurate identification, the information from router likes Explicit Congestion Notification (ECN) and Backward Congestion Notification (BCN) also used.

D. TCP RENO and TCP NEW RENO for Wireless

TCP Reno is the most widely adopted Internet TCP protocol. It employs four transmission phases: slow start, congestion avoidance, fast retransmit, and fast recovery. When packet loss occurs in a congested link due to buffer overflow in the intermediate routers, either the sender receives three duplicate acknowledgments or the sender's retransmission timeout (RTO) timer expires. In case of three duplicate ACKs, the sender activates TCP fast retransmit and recovery algorithms and reduces its congestion window size to half.

TCP New Reno is a modification of TCP Reno. It improves retransmission process during the fast recovery phase of TCP Reno. TCP New Reno can detect multiple packet losses. It does not exit the fast recovery phase until all unacknowledged segments at the time of fast recovery are acknowledged. Thus, as in TCP Reno, it overcomes reducing the congestion window size multiple times in case of multiple packet losses. The remaining three phases (slow start, congestion avoidance, and fast retransmit) are similar to TCP Reno [10].

In wireless networks with signal attenuation, fading, and multipath, TCP Reno outperforms other congestion control algorithms in terms of congestion window size and file download response time. The throughput and goodput in the case of TCP Reno is also higher than the remaining three algorithms. In case of wired networks, TCP Reno shows significant performance degradation in case of multiple packet losses.

III. METHODOLOGY

In this study, a proper methodology has been designed to get an expected output. This can be referred to the following work flow depicts in Figure 2.

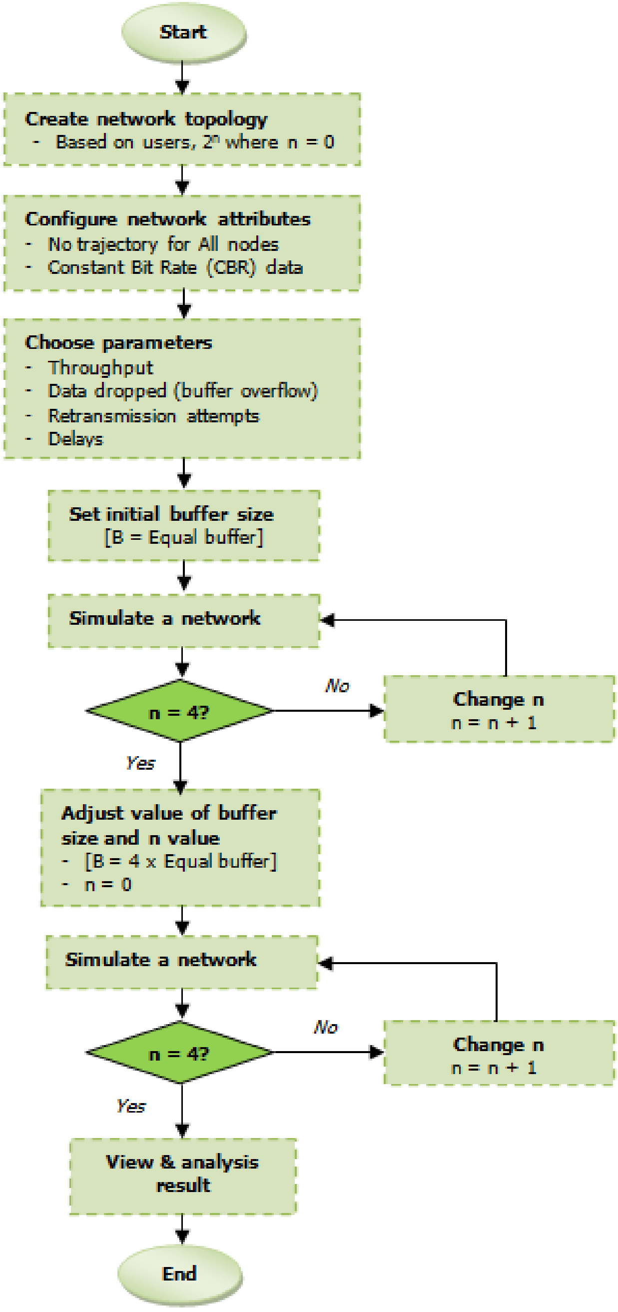


Figure.2 Methodology to be used

Start with defined a simple ad hoc network, the scalability of the network is determined by a formula 2^n where n is given as 0, 1, 2, 3 and 4.

For this study, mobility issue is out of our consideration. Therefore, all mobile nodes are set to be no trajectory. Here, the constant bit rate (CBR) data has been chosen (video streaming) in order to observe the packet behavior correspond to the changes of buffer size and users in wireless environment.

IV. PROPOSED WORKPLAN

A. The proposed network

In this section, a simple ad hoc network was designed as illustrated in Figure 2. This network consists of a group of mobile wireless users are located surrounding to a fixed wireless node as a ring topology. For all mobile nodes, they are considered as stationary nodes (no trajectory) and expected to work perfectly where all in-range of wireless coverage.

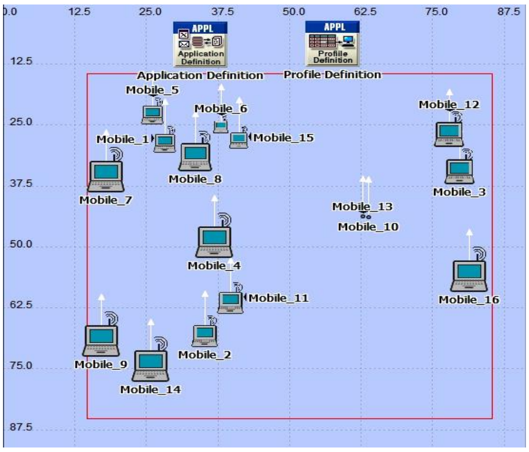
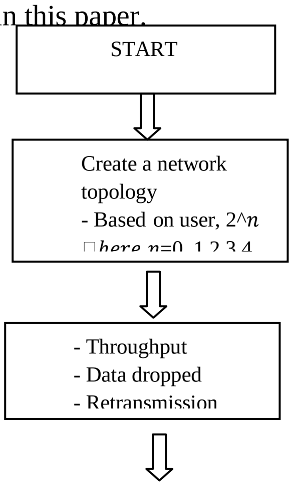


Figure 3. The Proposed Network

To Study the effect of node's buffer space in to packets of the network. Then, vary the power consumption and topology of networks to study the effect of network congestion, and how they may or may not be an important contributor towards network congestion.

B. Steps Required for further Simulation

The following Figure 4 shows flowchart simulation steps and reduces the network traffic. It helps to get expected result as defined in this paper.



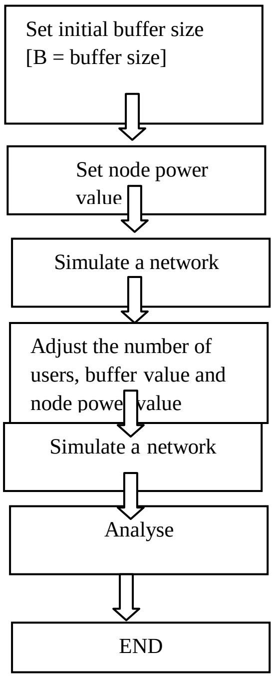


Figure 4. Flowchart for Simulation

V. PROJECT ANALYSIS

This report has presented an analysis of some IEEE 802.11b wireless ad-hoc networks specifically; we have investigated the effect of buffer size, mobility and node power level to the in flights packets congestion on network. The analysis of heavily congested wireless networks is crucial for the robust operation of such networks.

VI. FUTURE WORK

With the help of certain simulation conducted using OPNET Modeler 14.5 it can be determined as to how buffer size, mobility and node power can prove to be critical for ad hoc network performance. With a controlled size of users, the simulation result can show that the "larger node's buffer size and power level" at even a random mobility will makes network performance degradation more critical compared to the "small node buffer". This can be conducted throughout several selected parameters which are: low throughput, high number of packet dropped, high number of retransmission attempts and long. Therefore, this study can be further expanded by the changes of node's buffer space availability in ad hoc environment which plays an important role in order to have better the network performance.

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