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Some Results on a Scalable Congestion Control System

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Abstract

In this article, a congestion control system with the facility of load balancing is designed to solve congestion problem that may be associated with transmission of data over the internet. This will enable small scale service providers to have an uninterrupted and easy way of transmitting information over the internet, using affordable and scalable system that provides connectivity when other routes are down. Broader world of information and communications technologies (ICT) has exciting prospects in the Nigerian market, and will attain greater heights even quicker if congestion problems are totally eradicated and all technological tools are properly harnessed. Also, with a good congestion control on the telecommunication networks, users will start to enjoy their calls and internet services without much interruption or failures.

1. Introduction

MANET represents complex distributed systems that contain wireless mobile nodes that can freely and dynamically self-organize into temporary, ad-hoc network topologies. Mobility causes route failure. They require robust, adaptive

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communication protocols that can handle the unique challenges of these multi-hop networks smoothly. The TCP has been widely deployed as transport layer protocol on a multitude of internet works including the Internet, for providing reliable end-to-end data delivery. Several routing protocols are used in MANET. Reactive routing protocol AODV is used. Signal strength based metric produces better results compared with other protocols. Routing protocols are classified on different basis, routing protocols can be classified on the basis of topology.

Low bandwidth is notable as the cause of most congestion problem on the internet, because if there are enough channels (bandwidth) for data to pass through there would not be problem of congestion as such on the internet.

Due to emerging application requirements and also for reliable data transfer, congestion control with load balancing is a key research area in the field of mobile communication networks. In mobile communication network, job completion becomes complex, when their is low bandwidth and huge load is given to the nodes with less processing capabilities and which do not have any means to share the load, this results into a very serious congestion problem.

Moreover, there are situations where few nodes maybe idle and few will be over-loaded as a result of imbalance (that is, the computing/processing power of the systems is non-uniform); then the issue of load balancing comes in. A node which has high processing power finishes its own work quickly and is estimated to have less or no load at all in most of the time. So, in the presence of under-loaded nodes keeps idle, the need for over-loaded nodes is objectionable.

In a network with shared resources, where multiple senders compete for link bandwidth, it is necessary to adjust the data rate used by each sender in order not to overload the network, packets that arrive at a router cannot be forwarded are dropped, consequently an excessive amount of packets arriving at a network bottleneck leads to many packet drops. These dropped packets might already have traveled a long way in the network and thus consumed appreciable level of resources. Additionally, the lost packets often trigger retransmissions, which mean that even more packets are sent into the network. Thus network congestion can severely deteriorate network throughput. If no appropriate congestion control is performed this can lead to a congestion collapse of the network, where almost no data is successfully delivered. Such a situation occurred on the early internet, leading to the development of the TCP congestion control mechanism.

In this research, various literature review has been analyzed which deals with several routing approaches to congestion problems and load balancing problem. The work propose a design to solve congestion problem that may be associated with transmission of data over the internet.

2. TCP Congestion Control

On the Internet, congestion control is the responsibility of the transport layer, more precisely of the Transmission Control Protocol (TCP). TCP combines congestion control and reliability mechanisms. This combination allows the network to perform congestion control without the need for explicit feedback about the congestion state of the network, and without direct participation of the intermediate nodes.

To detect network congestion TCP simply observes occurring packet losses. Since the Internet missing packets are almost always caused by congestion, a missing packet is interpreted as a sign for network congestion. There are various means through which TCP solves congestion problems:

2.1. Cumulative Acknowledgments:

TCP receiver always acknowledges the end of the so-far correctly and completely received data when a new segment arrives. If segments are received out-of-order, i. e., some data is missing between the already known and the newly arriving data, the last acknowledgment is sent again (duplicate ACK).

2.2. Window-based Additive Increase, Multiplicative Decrease Mechanism:

TCP uses a window-based additive increase, multiplicative decrease mechanism. The window size is increased by one segment (i. e., additively) in every round-trip time when no packet losses occur. In case of the reception of a duplicate acknowledgment a TCP sender will first assume that some packet reordering has occurred in the network. But upon reception of the fourth copy of an acknowledgment (Triple Duplicate ACK, TDACK) a congestion loss is assumed. In this case the missing segment is repeated and the window size is cut in half (multiplicative decrease).

2.3. Use of Timeout:

Additionally, TCP uses a *'timeout'* mechanism that depends on the measured round-trip time of the connection. If this retransmission timeout (RTO) elapses without an acknowledgment TCP concludes severe congestion. Then the window size is reduced to one and the unacknowledged segment is sent again. The timeout until the next retransmission attempt if still no acknowledgment arrives is doubled. Thus this timeout grows exponentially.

3. Related Works

Barkha Shakya, Deepak Kulhare and Arpit Solanki (2013) studied various congestion control technique like routing base congestion control, window based, and additive increase decrease of window base as well as transport layer based congestion control technique. The techniques provide more reliable and efficient congestion control. A dynamic queue as well as acknowledgment delay based congestion control technique were proposed to provide a system that is more feasible to MANET environment. They increased the performance of the network like packet delivery ratio, throughput and minimize the end-to-end delay of the network.

Peter Key, Laurent Massoulié and Don Towsley (2007) presented the benefits of combining congestion control with multipath routing, showing that in a static setting, where random path sets are chosen, coordinated controllers outperform uncoordinated ones.

4. The Proposed Solution

The focus is to design a server system that is very fast in detecting congestions and activate maximum control measures to checkmate the congestion problem.
Moreover, the server shall be able to:

(1) distribute workloads between multiple internet sources, such as two 3G and DSL internet sources and vice versa;
(2) optimize resource used, maximize throughput, minimize response time, and avoid overload of any single resource;
(3) divide traffic between network interfaces on a network socket (OSI model layer 4) basis shortest path bridging; and
(4) combine the strength of each internet source produce a better internet with good bandwidth.

Load balancing is a process of combining or shifting the load of users among different internet sources. One can also define load balancing as the combining of more than one internet connections. Other names that can be giving to it are as follow: Load balancing, Load merging, Line Merging. It can be designed or built in such a way that one will combine two DSL Lines and One 3G internet connection or vice-versa and will get a combined speed of 3 internet connection in a single line. In this work a personal computer (PC) with two 3G USB modem is used.

Conceptually, more lines can be added as desired using the same principle.

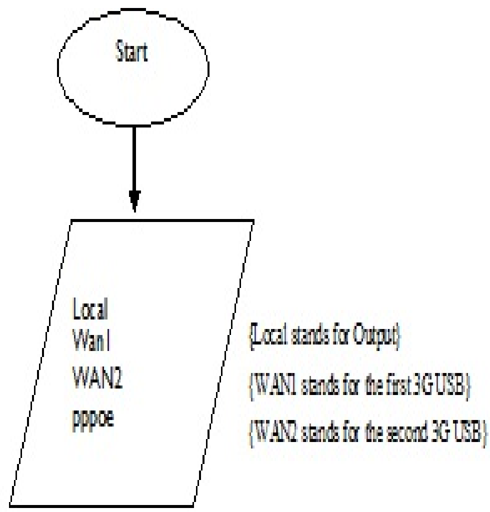

Figure 1: The Congestion Control System

The Algorithm for constructing the server is as follows:
start:
set the interface names
set the 3G USB username and password.
set ppp-out1 as WAN2.
   change the IP's of Modem1 and Modem2.
when 3G modem is ready,
   give IP addresses and names to WAN Links.
   set the IP addresses,
   assign the interface names
set the mangle rules for the server
   add new mangle rules for the WAN connections
   repeat for all required connections
add PCC (Per Connection Classifier) Rules.
end.

5. Output Results

The new server developed is a special server that was able to perform the following tasks:

(1) distribute workloads between multiple internet sources, such as two 3G and DSL internet sources and vice versa;
(2) optimize resource used, maximize throughput, minimize response time, and avoid overload of any single resource;

(3) divides traffic between network interfaces on a network socket (OSI model layer 4) basis shortest path bridging; and
(4) combine the strength of each internet source produce a better internet with good bandwidth.

The major interfaces generated during implementation settings include the following:
i. The Link Address:

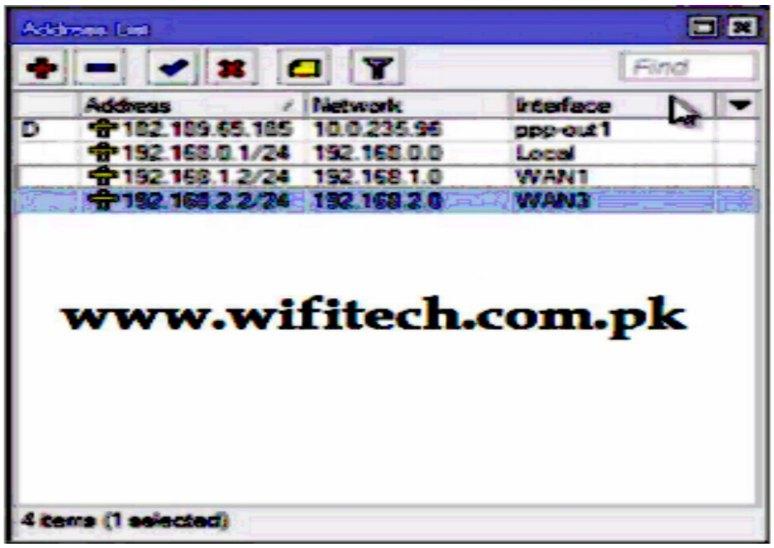

Figure 2: The Link Address settings

ii. The Mangle Rules

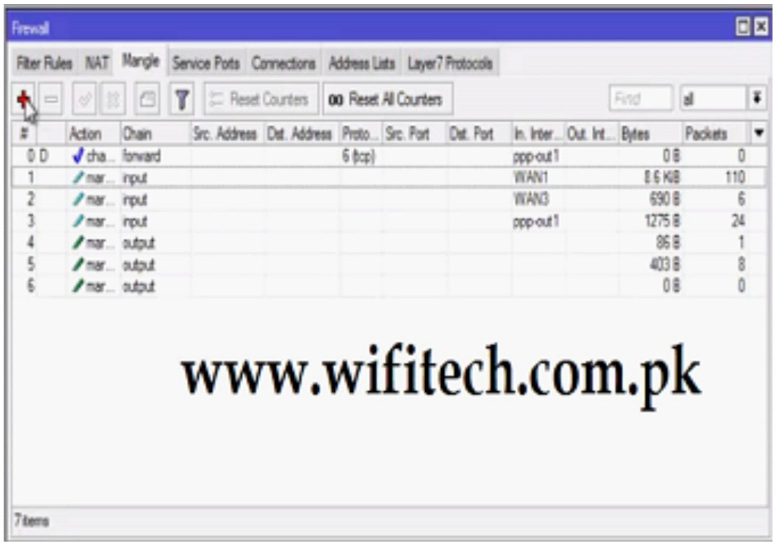

Figure 3: The Mangle Rules

iii. The Per Connection Classifier Rules (PCC)

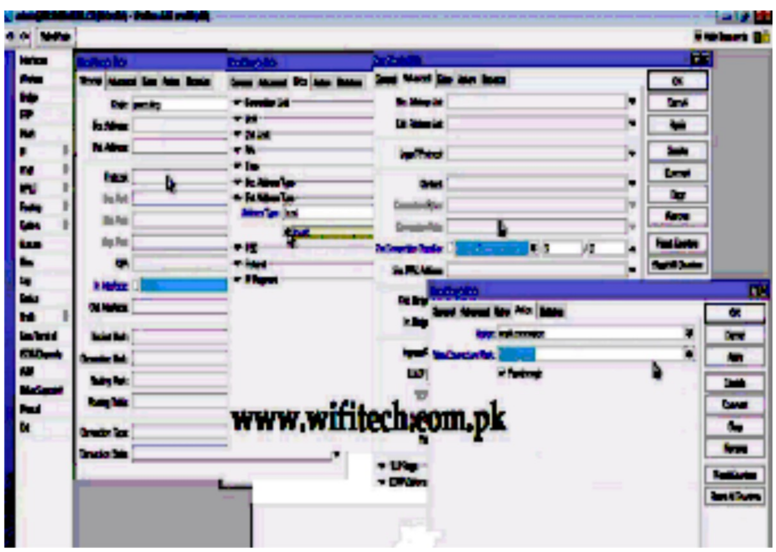

Figure 4: The Per Connection Classifier Rules PCC

iv. The Server System Connections

Figure 5: The Load Balancing Server System

Conclusions

The broader world of information and communications technologies (ICT) has exciting prospects in the Nigerian market, and will attain greater heights even quicker if all technological tools are properly harnessed.

Also, with a good congestion control on the telecommunication networks, users will start to enjoy their calls and internet services without much interruption or failures.

Congestion control and load balancing, when implemented well, can help telecommunication companies and others to meet their Internet performance, reliability, and redundancy goals, without stress. It also helps companies to have combination of signal strength from two or more internet sources so as to produce internet with a wide bandwidth instead of allowing their business rely on a single provider. This gives them greater opportunities for bandwidth control and contract flexibility.

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