Using TCP/IP Header Reserved bits to Reduce Packet Congestion

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Abstract- At present congestion in local and wide area networking protocols has become a major issue in computer networking. Due to this issue in congestion in computer networking there is a large number of negative outcomes. One of the most major negative outcomes have been the increased number of dropped data packets. Solely because of this reason, another number of issues come to life, such as since the sender buffer needs to keep the segments, until it receives an acknowledgement from the receiver. The receiver buffer needs to keep the segments, until the error checking is over, both these buffers tend to get overloaded and due to the overloading of these buffers the data packet congestion goes even higher. The research paper “TCP Congestion Control Scheme for Wireless Networks based on TCP Reserved Field and SNR Ratio” by Youssef Bassil (2012) proposes a new method to reduce these buffer overloads using the Transmission Control Protocol header reserved bits and reduce the congestion when transferring data packets. This research paper is based on the above mentioned research paper. This research focuses on using that method with the added ability to convey the type of the data which the data packet is carrying. Since some data types transfer important, time sensitive data and while the others carry data which are not as important and time sensitive, it would be valuable if there was a way to transmit the important and time sensitive data before the less important and less time sensitive data. The above mentioned research has a method to determine if a link is a wired link or a wireless link, this is important since research and as real life experience would agree that the wired links are more reliable and tends to drop a far low number of packets than wireless links. This research provides a method to transmit the important and time sensitive data through links with a wired connection rather than a wireless connection, first using the reserved bits of the transmission control protocol header. Using this new method, it would be easier to send important time sensitive data earlier than before. Though there is the possibility of less important and less time sensitive data been delivered consuming a little bit more time.

Index Terms- Transmission Control Protocol Header Reserved Bits, Congestion Control, Wired networking links, Receiver buffer, Sender buffer

I. INTRODUCTION

THe internet changed the view of the world of communications and computer. The invention of the telegraph, telephone, radio and the computer paved way for this unprecedented integration of capabilities. The internet was an anomaly with a world-wide broadcasting capability, an organism for information distribution and as a way for association, communication and interaction among humans and their computers regardless of their geographical location. The internet embodies one of the most fruitful examples of nonstop investment and obligation to research and development of the information infrastructure. Starting with the primary research in packet switching, the government, industry and academia have joined hands to evolve and deploy this exciting new technology. The original Advanced Research Projects Agency Network (ARPANET), was the early stage of packet switching networks and the very first network that implemented the protocol Transmission Control Protocol/Internet Protocol (TCP/IP) which was a networking protocol, became the internet. Internet was built on the idea that there would be numerous independent networks of relatively random design, beginning with the ARPANET as the original packet switching network, but quite soon to include packet satellite networks, ground-based packet transmitting radio networks and many other networks. The Internet as we now know it personifies a key underlying technical idea, explicitly that of an open architecture of networking. In this method, the choice of any specific network technology was not governed by a particular network architecture but rather be free of a provider and made to work and cooperate with the many other networks using a meta-level "Internetworking Architecture". The idea of an open-architecture of networking was first introduced by Kahn shortly after having arrived at The Defense Advanced Research Projects Agency (DARPA) in 1972. This work was initially part of the packet radio program, but later it became a separate program in its own right. During that period, the program was known and called "Internetting". The most crucial part in making the packet radio system work was a dependable end-end protocol that has the ability to preserve active communication in the event of jamming and other similar radio interference, or withstand intermittent blackout caused by being inside a tunnel or maybe blocked out by the interference of local terrain. Kahn first contemplated developing a new protocol local only to a packet radio network, and since that would evade having to deal with the gathering of different operating systems, and continuing to use NetWare Core Protocol (NCP).

Nevertheless, NCP did not have the ability to address both networks and machines further downstream than a destination Interface Message Processor (IMP) on the ARPANET and that some change to NCP might also be required. (The hypothesis on which this was based on was that ARPANET was not a variable in this respect). NCP depended on ARPANET to provide end-to-end availability and reliability. If any packets were lost or dropped, the protocol (and likely any applications it was supported) would come to a relentless halt. In this system NCP did not have end-end host error control, since ARPANET was to become the only network in existence and it would become so reliable that error control would not be required on the part of the hosts. Thus, Kahn decided to advance a new version of the protocol which could and would meet the needs of an open-architecture network atmosphere. This protocol would ultimately be called the TCP/IP. While NCP have a habit of acting like a device driver, the new protocol would act more like a communications protocol.

TCP/IP operated under four major rules:

- "Each distinct network would have to stand on its own and no internal changes could be required to any such network to connect it to the Internet;
- Communications would be on a best effort basis. If a packet didn't make it to the final destination, it would shortly be retransmitted from the source;
- Black boxes would be used to connect the networks; these would later be called gateways and routers. There would be no information retained by the gateways about the individual flows of packets passing through them, thereby keeping them simple and avoiding complicated adaptation and recovery from various failure modes;
- There would be no global control at the operations level"

In the spring of 1973, after he began the internetting struggle, he approached Vint Cerf (who was at Stanford during that time) to work with him on a thorough design of the protocol. Cerf was closely involved in the novel NCP design and advance and already possessed the knowledge about interfacing to existing operating systems. Together with Kahn's architectural style to the communications part and with Cerf's NCP experience, they worked together to spell out the facts of what turn out to be TCP/IP [10].

II. BACKGROUND AND RELATED WORK

In the research paper "TCP Congestion Control Scheme for Wireless Networks based on TCP Reserved Field and SNR Ratio" Youssef Basil came up with a research to control scheme for wireless networks based TCP reserved field and SNR ratio. The research is based on some aspects such as solving the performance problems over wireless networks. Furthermore, it allows the TCP protocol to distinguish between transmission timeouts due to errors. For the identification of the type of communication it uses the TCP reserved field. Youssef basil has introduced a SNR ratio to determine the reliability of the link through this it can take better decisions about the packet burst. This research paper is more similar work done as per the proposed research. Considering the above mentioned facts the research group add more functions to the proposed research such as the proposed research is based on a wired connection because through wireless networks it drops more packets. Moreover, the proposed research consists of identifying the most important messages to send first rather than sending less important message [1].

The research paper "Analysis of TCP Flags in Congested Network" mainly focuses on control flags of the TCP/IP header and this research was developed to implement HTTP header using two or three TCP/IP flags combining together. The research group mainly got Acknowledgement (ACK), Finish (FIN) and Urgent (URG) flags. Using these flags combining them together they hoped to build more secure and efficient HTTP header. The research team named that flags using first letters of flags such as, (FRA) FIN, RST and ACK. The proposed research is similar to the above mentioned methodology but the system that the group proposed is for the TCP/IP header by using the above mentioned flags in order to access it more effective and secure manner [2].

The research paper "Priority based Congestion Control Mechanism in Multipath Wireless Sensor Network" states that priority based Congestion Control Mechanism was proposed two-bits binary notification flag to notify the congested network status for implicit congestion detection. Congested network status, the research group propose a priority based rate adjustment technique for controlling congestion in link level. Congested packet will be distributed equally to the child node to avoid packet loss and transition delays based on a technique. The above mentioned techniques only apply for wireless networks. The proposed research mainly focused on both of wired and wireless networks [3].

The research paper "The Addition of Explicit Congestion Notification (ECN) to IP" describes about the tcp's use is to indicate the congestion of the packet drops. TCP's avoidance algorithms and congestion control are based on the idea that the network is a black-box. The state of congestion is determined by end systems visualize for the network state, by increasing the load on the network until the network becomes congested and a packet is lost. Treating the network as a "black-box" and treating loss as an indication of congestion in the network is appropriate for pure best-effort data carried by TCP, with little or no sensitivity to delay or loss of individual packets. These techniques are not to help applications that are sensitive to the delay or loss of one or more individual packets. Exclusive traffic such as web browsing, telnet, and transfer of audio and video data can be sensitive to packet loss (specially using UDP protocol) or to the increase level of the packet caused by the need to retransmit the packet after a loss. Since TCP find out the exact congestion window to use by often increasing the window size until it realizes a dropped packet, this causes the queues at the bottleneck router to build up. With most packets at the router that are not sensitive to the load placed by each individual flow, this means that some of the packets of level - sensitive flows may be dropped. In order to this, such drop policies motivate to synchronization of loss across multiple flows. Active queue management mechanisms detect congestion of the queue overflows, and provide an indication of the congestion to the end to end nodes. Since active management queue can decrease unwanted queuing delay for all traffic sharing of that queue. Active queue management decrease some of the bad properties of dropping on queue overflow, where the unwanted synchronization of loss over multiple flows. More importantly, active queue management means that transport protocols with mechanisms for control do not have to base on buffer overflow as the only indication of congestion [4].

The research paper "IP Authentication Header" states that IP Authentication Header (AH) is used to provide connectionless integrity and data origin authentication for IP datagrams and to provide protection against replays. Security Association is stabilized when optional service may be selected by the receiver. (The protocol default requires the sender to increment the sequence number used for anti-replay, but the service is effective only if the receiver checks the sequence number. Authentication header provides authentication for IP header as possible, as well as for the next protocol data. Headers not be predictable by the sender and some IP header fields may change in transit and the value of these fields changes when the packet arrives at the receiver. The values of such fields would not be authorized since the protection provided to the IP header by authentication header. The protocol header (IPv4, IPv6, or IPv6 Extension) showing the authentication header will contain the value 51 in its Protocol (IPv4) or Next Header. IP fragmentation occurs after authentication header processing within an IPsec implementation. Thus, transport mode authentic header is applied only to IP datagrams. An IPv4 packet to which AH has been applied may itself be fragmented by routers route, and such fragments must be reassembled prior to AH processing at a receiver [5].

The research paper "TCP Extensions for Multipath Operation with Multiple Addresses" articulates that TCP/IP communication is currently limited to a single path connection, since multiple paths exist between peers. The parallel use of these multiple paths for a TCP/IP session would develop resource usage within the network and, since develop user experience through higher throughput to network failure. Multipath TCP provides the ability to use multiple paths between peers. This paper presents a set of extensions to traditional TCP to support multipath operation. The protocol provides the same type of service to applications as TCP, and it provides the components important to establish and use multiple TCP flows across potentially disjoint paths. Multipath TCP (MPTCP) is a set of extensions to regular TCP to provide a Multipath service, which provides a transport connection to operate across multiple paths simultaneously. This paper summarize the protocol changes required to add multipath capability to TCP, specially which are for signaling and setting up multiple paths, controlling the sub flows, reassembly of data, and termination of sessions. This is not only information needed to create a Multipath TCP implementation, since This paper is combined with three others such as Architecture , which explains the motivations behind Multipath ,Congestion control which presents a safe congestion control algorithm for coupling the behavior of the multiple paths in order to "do no harm" to other network users and third describes Application considerations which discusses what impact will have on applications, what applications will want to do with it , and as a consequence of these factors, what API extensions an application implementation should present [6].

In the research paper "Reducing congestion using the TCP Header and file type identification" the method is provided for sending data from a data source executing a network protocol such as the TCP/IP protocol stack, which includes process for generating headers for packets according to the network protocol. The method incorporates sending such information on a system through a keen system interface. The network protocol defines a datagram in the information source, including creating a header format and supplying an information payload. The datagram is supplied to the network interface. At the network interface, a plurality of packets of data are generated from the datagram. The majority of bundles incorporate separate headers, such as TCP/IP headers, based on the header template, and include particular portions of the information payload. The network interface supports packets having a pre-specified length, and the information payload is more noteworthy than the pre-determined length, such as two to forty times larger or more. Thus, the higher layer information payload is more noteworthy than the pre-determined length, which is automatically portioned at the system interface layer, rather than at the TCP layer [7].For many years the Internet Assigned Numbers Power (IANA) has designated parameter values for fields in conventions which have been made or are kept up by the Web Engineering Task Force (IETF). Beginning a couple of years prior, the IETF started to give the IANA with direction to the task of parameters for fields in newly developed protocols. Unfortunately, this type of guidance was not consistently accommodated the fields in conventions created before 1998. This memo attempts to codify existing IANA practice used in the task of parameters in the particular instance of some of these protocols. It is expected that additional reminders will be produced later on to classify existing practice in other cases [8]. When experimenting with or extending conventions, it is regularly important to utilize some kind of convention number or constant in order to actually test or experiment with the new capacity, notwithstanding when testing in a shut domain. This document reserves some ranges of numbers for experimentation purposes in particular conventions where the need to bolster experimentation has been recognized, and it describes the numbers that have as of now been held by different archives [9].

III. OUR APPROACH

A. Aim

The aim of this research paper is to give out a new concept to reduce data packet traffic using the reserved bits and the flags of the Transmission Control Protocol (TCP) header.

B. Research Question

- The main research question that is addressed by this research paper is the congestion in Transmission Control Protocol Internet Protocol (TCP/IP).
- Sub research question that is addressed by this research paper is if it is possible and feasible to append the TCP header.

C. Objectives

The main objective of this research paper is to give out a new concept that has the ability to reduce congestion in TCP/IP using the flags in the TCP header and using two reserved bits to implement two new flags.

The sub objective of this research paper is to figure out if it is feasible to append the TCP/IP header.

D. Methodology

The basic TCP/IP header (as indicated by the figure 01 in the appendix) has 16 bits allocated for the source port address, 16 bits allocated for the destination port address, 32 bits allocated for the sequence number, 32 bits allocated for the acknowledgment number, 4 bits allocated for the header length which is also known as the offset, 6 bits reserved for any future improvements, 6 bits allocated for 6 flags which are urgent, acknowledgement, push, reset, synchronization and finish, 16 bits allocated for the window size, 16 bits allocated for the checksum, 16 bits allocated for the urgent pointer, and 32 bits allocated for options and paddings. This research paper focuses on the 6 reserved bits and the 6 flag bits to reduce the congestion in TCP/IP.

Though there are 7 layers in the Open Systems Interconnection (OSI) model, which are application, presentation, session, transport, network, data link and physical, there are only 4 layers in the TCP/IP model which are application, transport, internet and network interface. This does not mean that the TCP/IP model is a whole new model. The 4 layers in the TCP/IP model does contain all the 7 OSI model layers (as indicated by the figure 02 in the appendix). The application layer in the TCP/IP model contains the application, presentation and session layers of the OSI model, the internet layer in the TCP/IP model contains the network layer in the OSI model, and the network interface layer of the TCP/IP model contains both data link and physical layers of the OSI model.

As the main aim of this research paper is to give out a new concept that would reduce the congestion in TCP/IP using the reserved bits and the flags of the TCP/IP header it was decided by the research team that it is suitable to focus on the application layer of the TCP/IP model since it contains the session layer of the OSI model.

The proposed method to reduce congestion in TCP/IP, is by using 2 reserved bits and the flags of the TCP header. As mentioned in the research paper "TCP Congestion Control Scheme for Wireless Networks based on TCP Reserved Field and SNR Ratio" it is possible to determine if a data packet came through a wired or wireless medium. Using this method and by reverse engineering this method it would be possible to identify if a packet rout is using a wireless connection or a wired connection. It is general knowledge that wired connections are more stable and dependable than wireless connections and there are packets that are more critical and crucial than others. What the concept of this research paper does is send the more important and crucial packets via wired connections and send the less important packets via wireless connections.

In order to do the needful this concept uses the available flags in the TCP/IP header and two bits from the reserved bits and make them as two flags. The flags will be named important and wired connection. If a packet is important and time sensitive the flags important, wired connection and urgent will be set to the value "1". If a packet is important and not very time sensitive the flags important and wired connection will be set to the value "1". If the packet is not that important and not that time sensitive the value of both important and wired connection flags will be set to "0". While setting the values of these flags, there will be another mechanism running parallel to this which will figure out if the packet that is to be transmitted is a packet which was sent earlier and dropped or if it is a file that is been sent for the first time. If the packet is a packet that was dropped the mechanism will determine the cause for the packet been drop and if the packet was dropped due to an issue in the connection the mechanism will change the flags to change the route of the packet. As an example if a packet was previously sent through a wireless connection and was dropped several times, mechanism will change the flags and send the packet through a wired connection next time around but if by any chance the packet was sent through a wired connection and it was dropped the mechanism will try the same route again and if it still gets dropped the mechanism will change the flags and send it through a wireless connection. There is a possibility of criticism due to changing the wired connection into a wireless connection but the reality of the matter is that wireless connections are growing day by day and they are gaining popularity in the Information Technology field, this makes it possible to have multiple wireless connection routes to a destination which might only have one or two wired connections. By changing the flag from wired connection to wireless connection in this scenario could be proven useful in the practical environment. Even after trying out all the above mentioned methods, if the packet still gets dropped the mechanism will decide that the packet is been dropped due to congestion in the network and increase the value of "Time to Live" (TTL) and retransmit the packet again.

The value of the flag will be set in the session layer of the OSI layers but since this concept is for TCP/IP, this will be done in the application layer. This maybe a difficult concept to implement due to the complicated nature of the application layer of the TCP/IP, but if implemented could be vastly helpful in reducing the traffic in TCP/IP.

The other end of this concept is to program the routers to intelligently send these packets through wired connections and wireless connections. In order to do so, the routers will need a mechanism to figure out if the devices or rather the routers with which the routers are connected have wired connections or wireless connections.

E. Advantages

- The proposed research directly controls with the sender and the receiver without involving an intermediary.
- Transfer of data packets: Through the proposed research it sends the important and time sensitive data first without sending less wanted and less time sensitive data.
- Control of data packets: Flags will be used to decrease the drop of data packets in the proposed methodology.

IV. CONCLUSION

This paper is a novel scheme for solving the TCP performance problem over the wired and wireless networks. It allows the TCP/IP protocol to distinguish between transmission timeouts due to congestion and due to errors. The scheme uses the TCP reserved field to identify the type of the network. It made regarding whether to reduce packet burst or to retransmit a timeout packet. The proposed plan clearly shows it managed to determine the drop packets in the wired networks and timeouts due to error and not congestion. Finally, the research includes of identifying the most important messages to send first rather than sending less important message. The mentioned aspect is happened using control flags, combing two or more TCP/IP flags then the data packet will be send on securely and efficiently. Using this concept, it can find the dropped data packets and also using this technique the research group can decrease the loose of data packets. Though this concept has the possibility of been implemented, due to the change in the TCP header it might not be feasible.

V. Future Work

There are a number of points the development team is willing to modify in the system in the future. The first point is to focus on demonstrating the system in a real time environment and ensure the reliability of the system as well as the effectiveness, efficiency and accuracy of the system as this could be a difficult concept to implement due to the complicated nature of the application layer of the TCP/IP.

As another future work the team intends to make an actual algorithm in this system as well. The team also hope to develop and make the algorithm more advanced by making it possible to have multiple wireless connection routes.

The team also intendsto implement the system adhering to the latest network standards and make it possible to upgrade router and switch overtime to make sure the system runs according to the latest and more secure protocols up to date.

Appendix

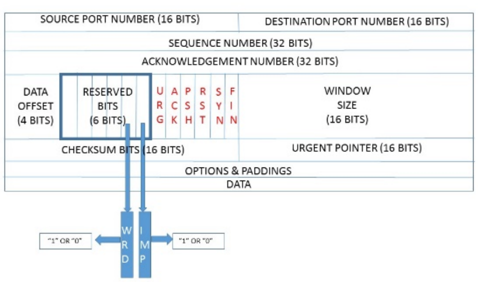

Figure 1: TCP Header

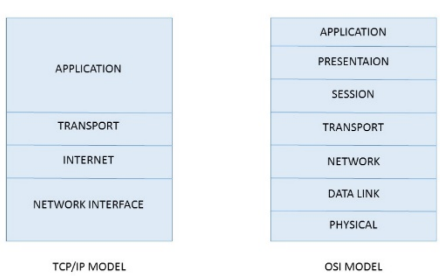

Figure 2: TCP/IP & OSI

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