Performance Improvement of TCP using Automatic Rate Fallback Algorithm (ARF)

Ankur Macwan[1]; Sanjay Shah[2]

Madhuben & Bhanubhai Patel women institute of engineering,Anand,Gujarat[12]

aamacwan@mbict.ac.in[1];skshah@mbict.ac.in[2]

ABSTRACT

Internetworking has evolved as backbone of communication in recent years. TCP/IP protocol suite is an inseparable part of internet. Hence the efficiency of the protocols plays a vital role in performance of internet. The protocol suit that was originally designed for a wired network is now required to function in the internet with wireless extension employed to reach remote areas. In a wired network, most packet losses are due to congestion. TCP exploits this characteristic of wired networks and tuned to perform well in such an environment. But in wireless environment, losses occur due to various factors like fading, attenuation, interference from other sources, and mobility of nodes. Because of all above factors the performance of TCP is degraded in wireless networks. To achieve high performance under these varying conditions, nodes need to adapt their transmission rate dynamically. In this paper, we propose a new automatic rate fallback algorithm (ARF) that can improve the performance of TCP in wireless network.

Keywords:. TCP/IP, Automatic rate fallback algorithm

1. INTRODUCTION

Wireless networks are becoming more widely deployed and more often used to access services in the internet. The Transmission Control Protocol (TCP) has become the predominant transport protocol in the internet today and convergence of mobile and fixed technologies. It is important to understand its performance especially over wireless links. The performance of the Internet protocols has been reported to be much lower than in fixed networks. TCP works less efficiently in wireless networks. In fixed network less than 1% of the packet losses is considered being due to link errors [1]. A missing packet means in most cases that the network is congested and in reaction TCP triggers the congestion algorithm aimed at reducing throughput. In the wireless network, however, packet losses occur more frequently due to link error because of unreliability of the physical link. This implies the unnecessary invocation of the congestion algorithm. Moreover this reduces the throughput drastically and causes severe performance degradation. connected to a wire line network by an inter-

working unit, and a wireless local area network (WLAN) is interconnected with an access point (also called base station).

Wireless links are not as robust as wire line links, since the radio quality may vary considerably over time, the bandwidth is usually lower, and transmission errors occur more frequently. Sending signals over an Omni directional radio based medium gives rise to more errors than in a guided medium such as fiber or coaxial cable. Signal strength weakens with the distance between the mobile station and the base station, and radio waves bounce off objects, giving rise to interference and multi-path effects. In order to shield upper protocol layers from transmission errors both error correction, interleaving and retransmissions can be used at lower layers. In many wireless networks, the data link layer performs error recovery according to some automatic repeat request (ARQ) protocol. Fig.1.1 shows basic idea of wireless network Wireless networks are formed by devices that are able to communicate with each other using a wireless physical medium without having to resort to a pre-existing network infrastructure. This implies that this network is a network established for a special, often extemporaneous service customized to applications. So, the typical wireless network is set up for a limited period of time. The protocols are tuned to the particular application. The application may change dynamically. Because of its mobile, non-infrastructure nature, the wireless network poses new design requirements. The first is self-configuration in the face of mobility. Wireless networking brings features like easy connection to access networks, dynamic multi hop network structures, and direct peer-to-peer communication.

2. *Wireless Network Characteristics*

The wireless networks hold following characteristics.

2.1 Mobility

The nodes can be rapidly repositioned or moved. The mobility model can have major impact on the selection of a routing scheme and can thus influence
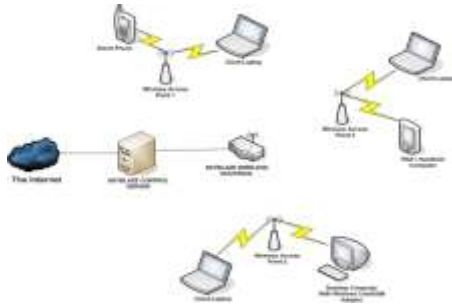
2.2 Multi hopping

A multi hop network is a network where the path from source to destination traverses several other nodes. Nets often exhibit multiple hops for obstacle negotiation, spectrum reuse, and energy conservation.

2.3 Self-organization

The wireless network must autonomously determine its own configuration parameters including: addressing, routing, clustering, position identification, power control.

2.4 Energy Conservation

In wireless networks mobile nodes are battery powered. The choice of the power level fundamentally affects many aspects of the operation of the network including quality of received signal, range of transmission and many more as well as lifetime of network.

2.5 Scalability

In some applications the wireless network can grow to several thousand nodes. For wireless "infrastructure" networks scalability is simply handled by a hierarchical construction. Thus, mobility, jointly with large scale is one of the most critical challenges in design.

3. Factors Affecting On Performance Degradation of TCP Over Wireless Network.

Compared with wired networks, wireless networks have some inherent adverse characteristics that will significantly deteriorate TCP performance described below.

3.1 Channel error

In wireless channels, relatively high bit error rate because of multipath fading and shadowing may corrupt packets in transmission, leading to the losses of TCP data segments or ACKs. If it cannot receive the ACK within the retransmission timeout, the TCP sender immediately reduces its congestion window to one segment, exponentially backs off its RTO and retransmits the lost packets. Intermittent channel errors may thus cause the congestion window size at the sender to remain small, thereby resulting in low TCP throughput.[2]

3.2 Mobility

Cellular networks are characterized by handoffs due to user mobility. Normally, handoffs may cause temporary disconnections, resulting in packet losses and delay. TCP will suffer a lot if it treats such losses as congestion and invokes unnecessary congestion control mechanisms. The handoffs are expected to be more frequent in next generation cellular networks as the micro-cellular structure is adopted to accommodate an increasing number of users. Thing could be worse if TCP cannot handle handoffs gracefully. Similar problems may occur in wireless LAN, as mobile users will also encounter communication interruptions if they move to the edge of the transmission range of the access point.[2]

3.3 Communication asymmetry

In one-hop wireless networks, the wireless link between a base station and a mobile terminal in nature is asymmetric. Compared with the base station, the mobile terminal has limited power, processing capability, and buffer space. Another asymmetry stems from the vastly different characteristics of wired links and wireless links. The former is reliable and has large bandwidth while the latter is error-prone and has limited and highly variable bandwidth. For example, the bandwidth of a typical Ethernet is 10Mbps (100Mbps or even higher for fast Ethernet) while the highest bandwidth for 3G networks is only about 2Mbps[2]. Therefore, the wireless link is very likely to become the bottleneck of TCP connections.

3.4 Higher end-to-end delay

As the wireless link capacity is limited, the data rate on wireless cannot reach values that are frequent on wired links. The presence of wireless section on a end-to-end connection will therefore slow down data traffic and increase the end-to-end delay. Retransmissions caused by erroneous packets also add a supplementary delay that should be taken into account in the global delay calculation. Moreover wireless systems often turn to coding and interleaving to cope with high error rate. These methods can increase the wireless delay to up to 100ms.[2]

3.5 Frequent disconnections

Handovers for instance often result in variation in packet delays or in packet losses that can lead to disconnections lasting from some packets (a few ms) up to a few frames (around 1 second). Besides, if a cell contains many users, some connections (of newly arriving mobiles) may not receive bandwidth for a long period of time – this call-blocking event can also be considered as disconnection. These disconnections result in TCP timing out and lowering its congestion window, thus reducing the efficiency of the transmission. As the mobile will reconnect, it will have to wait for TCP to time out before receiving more data. This trouble will become even more crucial in the future with the development of pico-cells. In fact this cell size reduction will lead to small cell latencies i.e. the user will not stay for long in a given cell but rather roam from one cell to another quite often.[2]

### 4. TCP PERFORMANCE IMROVEMENT OVER WIRELESS NETWORKS

Because of all above factor the performance of TCP is degraded in wireless network. Several solutions have been proposed to address the known problems that TCP faces when running over wireless networks. Of those solutions, Automatic rate fallback (ARF) is most effective. In this scheme nodes adapt their transmission rate dynamically.

5. AUTOMATIC RAte FALLBACK

The IEEE 802.11 Physical Layers provide multiple transmission rates by employing different modulation and channel coding schemes. However, in Medium Access Control (MAC) layer, 802.11 only specify which transmission rate is allowed for which type of MAC frames, but not how and when to switch the rates.

The idea behind ARF is that each sender tries to use a higher transmission rate after a set number of successful transmissions at the current rate. If it experiences one or two consecutive losses, it falls back to the next lower rate. When ARF increases the sending rate, the subsequent transmission decides if ARF will continue to use the higher rate or fall back to the previous lower one.

The algorithm works as follows:
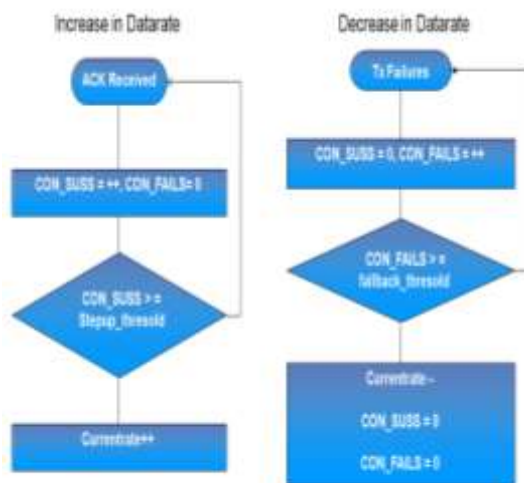
The current ARF algorithm uses a simple count of consecutive receptions and failures of an acknowledgment.

Receptions and failures are the result of individual transmissions, such that a packet retransmitted once would count as a failure followed by a reception. Four consecutive receptions trigger a rate increase if possible, while 2 consecutive failures trigger a rate decrease.

6. Simulation Result

In order to analyze the performance improvements brought by the ARF, simulation is carried out using NS-2. The 802.11 implementation already available within NS-2 have been extended in order to incorporate the more recent 802.11g specificities
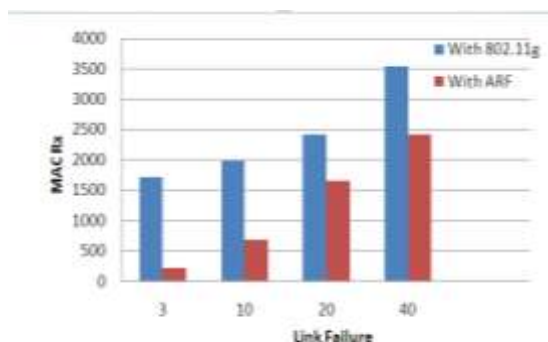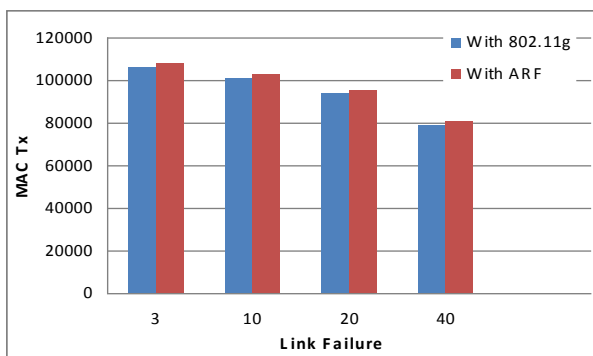
The simulation is carried out using a wired-cum-wireless scenario in which last hops is wireless. This wireless hop sends a TCP traffic flow to a wired network as shown in Fig In scenario signal failures are obtained by moving node_0 to the limit of the coverage area. In simulation the Newreno is used as agent for TCP traffic generation. The total simulation time is 250s. In the simulation 802.11g is used for wireless hop which is displaced at the coverage area during simulation time. The wired line has capacity of 100Mbps and delay is 10ms.

Observation and Trace File based Analysis

6.1.1 TCP Performance comparison between 802.11g and 802.11g+ARF
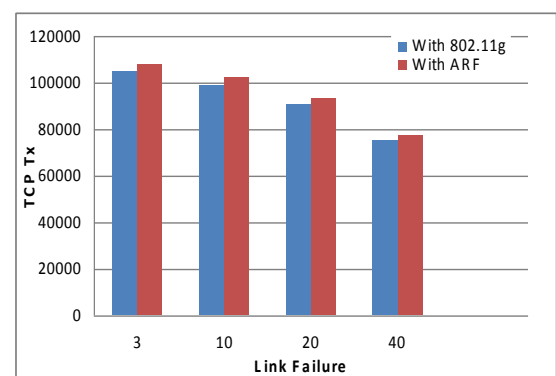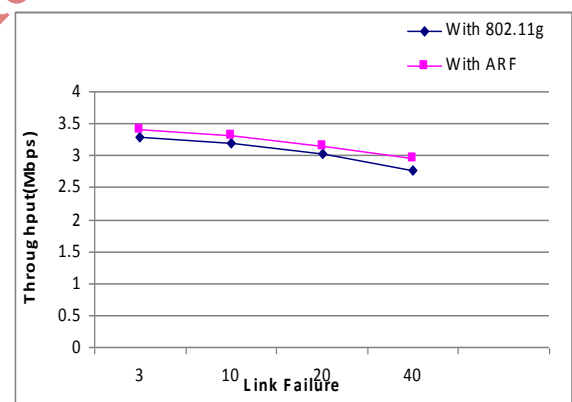
transmissions are increased so ultimately total number of MAC transmissins are increased.

6.1.3 ARF Performance with bad link condition

Time for MAC resolution is high in ARF in comparison with 802.11g, when wireless link is not connected which in turn reduces MAC retransmissions even in the presence of high error.

Here, MAC resolution time when wireless link is not connected is high in ARF.So in the loss duration period number of MAC retransmission are low in ARF. So total number of MAC retransmissions are low in ARF.

- In comparison with 802.11g when we use Auto Rate Fallback algorithm(ARF) end to end TCP throughput is increases with the help of increase in total MAC transmissions. ARF also reduces number of MAC retransmission.

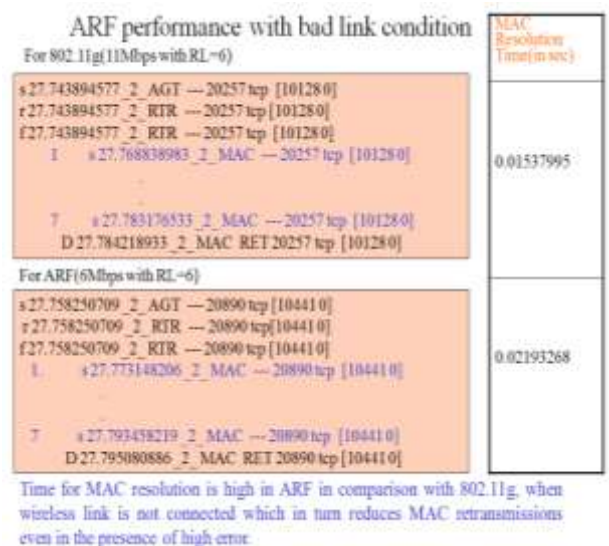### 6.1.2 ARF Performance with better link condition

MAC resolution time in ARF is less when link is connected so that ACK are coming faster in ARF so more no. of TCP packets are transmitted.

Which results in increase in total number of MAC transmission.

Here, MAC resolution time when link is connected is less in ARF so MAC acknowledgments are coming faster in ARF. So More number of TCP data packets are transmitted .So number of TCP transmissions are high in ARF. As total number of TCP

7. Conclusion

By this paper we can conclude that performance of any process is improved of TCP by ARF.

REFERENCES

[1] Fabienne LEFEVRE, Guillaume VIVIER: "Understanding TCP's behavior over wireless links", Motorola Labs – Centre de Recherche de Motorola – Paris.

[2] Hari Balakrishnan, Srinivasan Seshan, Elan Amir and Randy H. Katz.

"Improving TCP/IP Performance over Wireless Networks."

[3] Dzmitry Kliazovich and Fabrizio Granelli. "A Cross-layer scheme for TCP Performance Improvement in Wireless LANs."

[4] S. Goel and D. Sanghi.: "Improving TCP performance over wireless links. *Proceedings of TENCON 98 - IEEE Region Ten Conference on Global Connectivity in Energy, Computer Communication and Control*, 1998

[5] Christina Parsa J.J, Garcia-Luna-Aceves"Improving TCP Performance over Wireless Networks."

[6] Stephane Lohier, Yacine Ghamri Doudane, and Guy Pujolle"Cross-Layer Loss Differentiation Algorithms to improve TCP Performance in WLANs".

[7] *Stephane Lohier, Yacine Ghamri Doudane, and Guy Pujolle:* " The Benefits of a Cross-Layer Approach for TCP Performance Improvements in WLANs"

[8] S. Cen, P. C. Cosman, and G. M. Voelker "*End-to-End differentiation of congestion and wireless losses*", IEEE/ACM Transactions on Networking (TON), 2003.

[9] S. Bregni, D. Caratti, F. Martignon "*Enhanced Loss Differentiation Algorithms for Use in TCP Sources over Heterogeneous Wireless Networks*", Globecom 2003.

[10] H. Balsrishanan, S. Seshan and R. H. Katz: "A comparison of mechanisms for improving TCP performance over wireless links", *Proceeding of ACM SIGCOMM'96, Aug. 1996*

[11] ns manual http://www.isi.edu/nsnam/ns/ns-documentation