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30. Adaptive TCP for Diverse Wireless Interfering and Impaired Channel Characteristics during VHO for Global Seamless Mobility

Abstract

Wireless transmissions are characterized by several propagation impairments that primarily differentiate them from transmissions along the guided mediums. Some of the propagation effects like free space path loss, blocking or shadowing, scattering, diffraction, multipath propagation, Inter Symbol Interference (ISI), fading and delay spread adversely affect the performance of telecommunication networks. Resultantly all performance parameters designed for networks running on guided mediums can not be taken as a bench mark for the wireless domains. In fact, the impaired wireless channel characteristics, in turn, affect the optimal utilization of scarce available wireless bandwidths and calls for adapting the applications to embrace these effects without affecting Quality of Service (QoS) or providing desired Service Level Agreements (SLAs). With deployment of more and more wireless technologies and networks, the problems caused by adverse wireless channel or propagation characteristics become more and more complex.

Seamless global mobility, the main driving concept for 4G systems, requires integration of heterogeneous wireless networks. This has led to the evolution and adaptation of protocols at various layers of OSI model to mitigate the adverse wireless effects and provide interworking functionalities among heterogeneous wireless and wired networks. The network heterogeneity coupled with wireless interfering and impaired channel characteristics raise an important question that is to decide the right place for implementing the changes. In this regard, tremendous research efforts are in place suggesting changes in the application, transport, network and data link layers. However, changes in the lower levels have inherent limitations. They cannot have enough information about the requirements of the applications, protocol parameters, and device limitations. Resultantly it cannot implement the whole function of error control. Perhaps we can only optimize the functionality of higher layers. Therefore, in this thesis, I have concentrated on the transport layer TCP protocol performance enhancement.

Transmission Control Protocol (TCP) presents insufficient error control mechanisms and requires adaptation to the typical wireless error prone scenarios. The issue is further aggravated when seamless mobility calls for vertical handoffs among heterogeneous networks, thereby

causing frequent TCP Slow Starts (SS) and activating Congestion Window (Cwnd) error recovery algorithms. While TCP error recovery mechanism targets the congestion in the network, it can not differentiate between congestion and wireless link errors. Therefore, TCP losses the opportunity for error free transmissions during transient wireless impairments and can not dynamically adapt to the changing bandwidths quickly due to SS.

In this thesis, the impact of various wireless link propagation and handoff effects on TCP performance especially when the handoff occurs from a high bandwidth to a low bandwidth system is studied. The network model comprises a wired cum wireless scenario. FTP session is established between the wireless and wired nodes traversed along the low bandwidth wireless and high bandwidth wired Packet Data Networks. I have concentrated on the effects of high Round Trip Time (RTT) on TCP throughput and Cwnd performance. Higher RTTs in turn affect the retransmission times, overheads on the available bandwidth and require inflated Retransmission Time Out (RTO) timers. Hence the overall performance is degraded especially when VHO is upward. I have calculated the Round Trip Time (RTT), Cwnd and Throughput in three different varying wireless conditions; ideal, moderate and poor during Vertical Handoff (VHO) in an end to end TCP connection. The results were recorded. The TCP connection was then split at the BS node (gateway to support store and forward) and link delays were estimated and results were recorded. Then a probing mechanism was devised to estimate the link delays under varying conditions to develop a correlation function for an end to end TCP and split TCP performance estimation.

Based on these performance calculations it revealed that TCP performance showed improvement in case of split connections as shorter RTTs were experienced. In order to further improve the performance, an adapted Cwnd approach was used for a split and end to end TCP connection. Cwnd was adapted to the Bandwidth Delay Product (BDP). The simulation results show an average 10-15 % throughput enhancement for split TCP. An additional performance improvement of 12-15 % was achieved by adapting Cwnd to an optimum according to BDP. This scheme is named as "*Adaptive TCP for Diverse Wireless Interfering and Impaired Channel Characteristics during VHO for Global Seamless Mobility* ".