Chapter 1
TCP for Wireless Internet: Solutions and Challenges

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ABSTRACT
The importance of TCP as a transport control protocol comes from its wide usage in most implemented data packet communication networks all over the world. Because TCP was mainly developed to be implemented within wired networks, the continuous development and enhancements of its functionality and its control algorithms to catch up with the on-going development of different and new data packet communication networks, topologies, and technologies has represented non-stop work and effort.

The authors aim in this chapter is to discuss the main TCP issues and challenges that influence TCP performance, within different wireless data packet communication networks, taking into consideration the specific characteristics of each of them.

The authors present, in this chapter, the work done in order to improve TCP performance and to cope with new data transmission network technologies and topologies (such as Wi-Fi, WiMAX, cellular, wireless, mobile, ad-hoc, Mesh, and Vehicular networks). They also discuss the remaining research challenges that should be studied and evaluated within such wireless networks.

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INTRODUCTION

TCP is known, nowadays, as the most popular and widely implemented transport protocol. Although TCP was mainly developed to be used within wired data networks, the evolution of data networks technologies and topologies had not affect its popularity or its implementation as the researches are continuing to keep studying and enhancing its ability to cope with these new technologies. The development of TCP to meet these new technologies was a crucial milestone and a hard-working task in the domain to keep it still in the track. Over several years, many TCP variants were developed and implemented to keep up with the continuous communication technology evolution that invades our lives.

The development of TCP takes different scales. Some researchers were concerned by its development over wired data networks while others were oriented towards solving the challenges raised from wireless data networks. Certainly, dealing with each type of networks requires specific and well adapted solutions as the challenges and problems within each data network type are not the same. For example, within wireless cellular data networks, the main problem resides in the wireless link characteristics representing the last hop within the network configuration. Wireless links introduce new challenges to traditional TCP processes. These challenges are often expressed in terms of new data packet loss situations due to the specific characteristics of these networks. These new challenges require TCP enhancements and modifications for its embedded functional algorithms and sometimes its calculation processes. This is made with the aim to get an optimal behavior from TCP in terms of bandwidth usage.

The modifications proposed for wireless cellular data networks still does not satisfy the requirements of wireless multi-hop data networks, as almost all the communication links are wireless links, which amplify the wireless link challenges to TCP within such networks. Thus, solutions or TCP enhancements that address wireless cellular data networks problems are different from those dealing with multi-hop wireless data networks. Consequently, new TCP enhancement solutions were also proposed, implemented and analyzed as soon as new wireless data network technologies and topologies came into prospective (e.g. mobile ad hoc networks, wireless sensor networks …).

In this chapter, we are concerned by the development of TCP within wireless data networks. We start by explaining the different concepts of each data network topology/technology and the challenges that could affect TCP performance within such networks and then detailing the state-of-the-art solutions proposed to overcome these challenges within each of such wireless data networks. The research challenges that are still open will also be detailed. More precisely, in this chapter, we intend to discuss and compare different TCP variants and mechanisms that had been mainly developed to enhance the data packet transmission process over different single or multi-hop wireless data networks. Some of these variants are developed through a microscopic (i.e. details oriented) point of view manner while others were dealing with the macroscopic (i.e. global problem addressing) point of view.

We will start by introducing each wireless data packet network type and showing its main characteristics and the new challenges that may affect TCP performance when implemented within it. Then, we discuss, in details, the existing TCP solutions that are proposed and developed in order to enhance TCP performance within such networks. Finally, we investigate the possible remaining or new challenges to TCP that might be in perspectives to be discussed and dealt with within the discussed wireless data networks.

The discussed wireless data packet networks, in this chapter, include: (1) infrastructure single-hop networks (Wi-Fi or 802.11 Wireless LANs, WiMAX networks, and mobile cellular networks), (2) infrastructure-less multi-hop networks (mobile ad hoc networks, wireless sensor networks,
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