Cooperation for Secrecy in Wireless Networks

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Abstract

The growth of wireless networks has been considerable over the last decades. Due to the broadcast nature of these networks, security issues have taken a critical role in today’s communications. A promising direction towards achieving secure communications is information theoretic secrecy, which is an approach exploiting the randomness of the channels to ensure secrecy. Based on this approach, there has been a recent surge of interest in a potential cooperation between users to enhance the secrecy of communications. In this thesis we investigate the interaction between cooperation and secrecy. In particular the contributions of the thesis can be divided into two parts.

In the first part, we study cooperative strategies for secrecy for wireless channels. Our goal is to evaluate the effect of fading and limited CSI on the eavesdropper’s channels. In that purpose we consider a scenario where a helper aims at increasing the secrecy of the communication between a source and destination in the presence of an eavesdropper. Several strategies are discussed for the helper, namely decode-and-forward, amplify-and-forward, and cooperative jamming. We introduce the secrecy outage probability, the conditional secrecy outage probability and the secure throughput as secrecy measures. For each measure, we investigate and compare the secrecy performance of cooperation. We furthermore elaborate a system optimization in terms of strategy selection, node positioning, power allocation and rate design.

In the second part, we consider cooperation in the 4-node scenario against a more sophisticated adversary: an active eavesdropper, which can either passively eavesdrop, or jam the transmission. A game-theoretic perspective is a natural way to analyze the competitive interaction between the helper and the eavesdropper. Therefore we define several secrecy games, for which we find the Nash and Stackelberg equilibria as well as the corresponding secrecy rate outcomes. Another important consideration in this scenario is the interaction between the source and the helper, which we model and solve as a Stackelberg game, and we illustrate its impact on the achievable secrecy rates.