Wireless Sensor Networks (WSNs) are emerging technologies that have the ability to sense, process, communicate, and transmit information to the destination, and they are expected to have significant impact on the efficiency of many applications in various fields. The resource constraint such as limited battery power, is the most challenging aspect in a WSN design as it affects the lifetime and performance of the network. An energy efficient, secure, and trustworthy system is significantly important where some information in WSNs is highly sensitive. Thus, it is critical to design energy efficient and secure mechanisms while at the same time maintaining the desired level of quality of service. Motivated by such trends, this dissertation is dedicated to exploiting optimization and game theoretic approaches/solutions to handle several important issues in WSN communication such as energy efficiency, latency, congestion, dynamic traffic load, and security. We present several novel mechanisms to improve the security and energy efficiency of WSNs. Two new schemes are proposed for the network layer stack to enhance energy efficiency through optimized sleep intervals, and, at the same time, considers the underlying dynamic traffic load. We further work on developing the routing protocol in order to handle the wasted energy, congestion, and clustering. We propose an efficient routing and energy efficient clustering algorithms based on optimization and game theory. Furthermore, we proposed a dynamic game theoretic framework (i.e., hyper defense) to analyze the interactions between attacker and defender as a non-cooperative security game that considers the resource limitation. All the proposed schemes are validated by extensive experimental analyses, obtained by running simulation depicting various situations in WSNs in order to represent the real world scenarios as realistically as possible. The results show that the proposed schemes achieve a high performance in different terms, such as network lifetime, compared with the state-of-the-art schemes.

Keywords: Wireless sensor networks, energy, efficient, security, game theory, routing, clustering, attack, defense, duty cycle, network lifetime, optimization, quality of service.

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The public is welcome to attend.