In a distributed wireless system, multiple network nodes behave cooperatively towards a common goal. Though such assumptions on cooperation are desirable (e.g., controlling the transmit power level, reducing interference for each other, revealing private information, adhering to network policies) for analyzing and modeling, certain nodes belonging to a real-world system have often shown to deviate. These nodes, known as misbehaving nodes, bring more challenges to the design of the wireless network because the unreliable channel makes the actions of the nodes hidden from each other.

In this dissertation, we analyze two types of misbehavior, namely, selfish noncooperation and malicious attacking. We apply game theoretic techniques to model the interactions among the nodes in the network. First, we consider a homogeneous unreliable channel and analyze the necessary and sufficient conditions to enforce cooperative packet forwarding among a node pair. We formulate an anti-collusion game and derive the conditions that achieve full cooperation when the non-cooperative nodes collude. In addition, we consider multi-hop communication with a heterogeneous channel model. We refine our game model as a hidden action game with imperfect private monitoring. A state machine based strategy is proposed to reach Nash Equilibrium. The strategy attains cooperative packet forwarding with heterogeneous channel and requires only partial and imperfect information. Furthermore, it also enforces cooperation in multi-hop packet forwarding. To tackle the malicious attacks, we use Bayesian game analysis to show the existence of equilibrium in the detection game and argue that it might not be profitable to isolate the malicious nodes upon detection. We propose the concept of “coexistence with malicious nodes” by proving the co-existence equilibrium and derive the conditions that achieve the equilibrium.

This research is further accomplished by extensive simulation studies. Simulation results illustrate the properties of the games and the derived equilibria. The results validate our design philosophy and clearly indicate that the proposed game theoretic solutions can be effectively used to enforce cooperation and mitigate attacks.

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The public is welcome to attend.