LABORATORY FOR COMMUNICATIONS AND APPLICATIONS LCA

Cooperation in Wireless Networks

Why is cooperation an issue?

Traditionally, network protocol designers assume that their protocol will be correctly executed.
This **cooperation** assumption is based on the fact that the devices are controlled by the same authority. However, in emerging self-organizing networks this basic assumption might not hold. In the uncontrolled or vulnerable networking environments, where these networks are typically deployed, each device is controlled by a potentially **selfish** participant who can tamper with the networking protocols of its device to exploit the network at the expense of other participants. This behavior is very dangerous since it can lead to the collapse of service provisioning in the network. Thus, motivating the participants to cooperate becomes a key issue in self-organizing networks.

Analysis with Game Theory

In our analytical studies, we mostly rely on the mathematical principles of game theory. Game theory provides a framework to study the behavior of selfish (meaning rational) participants in any strategic interaction. Game theory has been successfully applied to many areas such as economics, biology and political science. In our research, we focus on networking problems where the participants are users who can modify the pre-programmed protocols of their devices.

Cooperation vs. Security

Cooperation and security are closely related issues. A network that is robust against attacks is called *secure*. A network that is robust against strategic behavior of users is called *strategy-proof*. In general, the strategy-proof property characterizes a network where cooperation is the most beneficial choice for the users. Accordingly, in the security context the attacker is assumed to be *malicious*, whereas in a strategy-proof context the participants are *selfish*. The major difference between the two adversary models is: a malicious attacker wants to jeopardize the operation of the network, but a selfish user wants to exploit it.

Application Areas

We have studied several issues in selfish wireless networking. Our investigations cover several network types such as 802.11 (Wi-Fi), sensor and ad hoc networks. We can relate our work to them as follows.

Introduction	- tutorial with wireless networking examples **[18]**
Ad hoc networks	- cooperation without incentives **[3,5,13]**
	- incentives for cooperation: currency **[1,4]**
	- incentives for cooperation: reputation system **[11,15,16]**
Hybrid ad hoc networks	- incentives for cooperation **[2,14]**
Sensor networks	- cooperative packet forwarding **[9]**
Cognitive radio	- multi-radio channel allocation [19,23]
Cellular and Wi-Fi networks	- spectrum sharing in cellular networks **[17,20]**
(WWANs and WLANs)	- selfish behavior in CSMA/CA **[7,10]**
	- reputation-based Wi-Fi development **[6,8]**

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RELATED

At EPFL

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MICS
Security and Cooperation in Wireless Networks - A Graduate Textbook
CSMA webpage
DOMINO webpage
Vehicular Communication
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