The capacity and architecture of wireless networks

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Abstract. Wireless networks could possibly be on the cusp of a take-off. In such "ad hoc" networks, a group of nodes can spontaneously form a network, where the nodes cooperate with each other in transporting information from sources to their sinks. The purpose of these lectures is to develop a theoretical foundation for analyzing and designing such networks. The course will be tailored to mathematical audience.

The primary questions we aim to address are: (i) How much information can wireless networks carry? (ii) What should be the architecture and strategy for carrying information in wireless networks?

We will begin with a description of classical information theory of Shannon which is addressed at the situation of two nodes where one mode wished to send information to the other node. This theory is notable for several aspects: (i) It precisely formulates the problem of communicating information. (ii) It solves the problem of how much information can be communicated. (iii) It determines an optimal architecture.

Our broad goal is to develop a similar theory for wireless networks, where there are many nodes, or just two nodes. Any or all of the nodes can be a source of information, a sink, or just a node that helps other source-destination pairs.

We begin with developing a theory to study capacity and architecture for wireless networks under a model that reflects commonly used technology. We study both what wireless networks can support under the best possible locations of nodes, traffic requirements, etc., as well as what a random network can support.

Subsequently, we aim to relax the constrain that nodes can only use commonly used technology, and turn to what are the ultimate limits to information transfer in wireless networks. This leads to an information theory for wireless networks. We show how this theory can provide architectural insights.