Linear Network Coding for Multicasting

6.454 presentation: Uri Erez

November 4, 2003

Abstract

By the well known max-flow min-cut theorem a source node s can send information through a network to a sink t at a data rate equal to the capacity of a minimal cut separating s and t. The information flow through a network has traditionally been thought of as that of a "physical commodity" and correspondingly the operation at nodes has been restricted to routing. It has recently been realized that for more complex networks (multiple source/sinks) this view is not adequate and that by allowing coding to be performed at intermediate nodes transmission at higher rates is possible. Specifically for a system with source s and multiple sinks $t \in T$, let $h = \min_{t \in T} MAXFLOW(s \to t)$ be the minimum of the achievable (single) flows from the source to any particular sink. We further assume that the same information is to be sent to all sinks, i.e., this is a multicasting scenario. Then it has been shown that we may multicast at rate h to all sinks using network coding. The coding operations may be restricted to linear operations on blocks of bits. The length of the block has the significance of the delay inherent to the coded system and bears upon issues such as encoding and decoding complexity. Furthermore, polynomial time algorithms for finding a linear coding system for a given network have been proposed, requiring block-length no greater than the logarithm of the number of sinks. We will review these results and discuss some extensions to the basic setup.