Abstract  Downlink beamforming refers to the problem of using an array of antennas at a particular node (e.g., a basestation) in a wireless network to communicate simultaneously with multiple co-channel users. The users in the network may have a single antenna, and hence no ability for spatial discrimination, or they may have multiple antennas and the ability to perform some type of interference suppression. The primary issue is how to balance the need for high, received signal power for each user against the interference produced by the signal at other points in the network. In this presentation, we describe several approaches to this problem: channel inversion, regularized channel inversion, channel block diagonalization, coordinated transmit/receive beamforming, and dirty-paper coding. While the basic idea behind these algorithms is the same, namely the use of channel information at the transmitter to predict and then counteract the interference produced at each node in the network, each of the algorithms is based on achieving a different performance objective. Typical performance criteria include zero-interference transmission, minimum transmit power subject to a minimum signal-to-interference plus noise ratio at each receiver, or maximum throughput subject to a given transmit power constraint. We compare the various goals of the above algorithms, and detail their respective advantages and disadvantages in terms of computational complexity, required transmit power, network throughput, and assumed receiver capabilities. The results of several simulation studies are presented to quantify these comparisons.