Achieving high spectral efficiencies in wireless networks generally requires that the nodes exchange information about channel and interference conditions. This information exchange requires signaling overhead (expenditure of power and bandwidth), which should be minimized subject to meeting performance objectives. The relation between signaling overhead and performance is discussed in three scenarios. In the first scenario, limited training and feedback are used to optimize the transmitted power distribution over a wideband, frequency-selective, block-fading channel. We characterize the growth in achievable rate as a function of the channel coherence time T. In the second scenario, limited training and feedback are used to determine beamformer coefficients at the transmitter, assuming a narrowband, block-fading channel. We show that the performance is limited by channel estimation error, and that to maximize the achievable rate, the number of transmit antennas should increase as T/log T. Finally, we consider an ad-hoc network of peer-to-peer users, and specify the information exchange among nodes, which is needed for optimal (utility-maximizing) power control.

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