Control over wireless sensor and actuator networks is of growing interest in process industry since it enables flexible design, deployment, operation, and maintenance. An important problem in industrial wireless control is how to limit the amount of information that needs to be exchanged over the network. In this thesis, network scheduling and remote control co-design is considered to address this problem.

In the first part, we propose a design of an optimal network schedule for state estimation over a multi-hop wireless sensor network. We formulate an optimization problem, minimizing a linear combination of the averaged estimation error and transmission energy. A periodic network schedule is obtained, which specifies when and through which routes each sensor in the network should transmit its measurement, so that an optimal remote estimate under sensor energy consideration is achieved. We also propose some suboptimal schedules to reduce the computational load. The effectiveness of the suboptimal schedules is evaluated in numerical examples.

In the second part, we propose a co-design framework for sensor scheduling, routing, and control over a multi-hop wireless sensor and actuator network. For a decoupled plant and LQG control performance, we formulate an optimization problem and show that the optimal schedule, routing, and control can be obtained locally for each control loop. In this part, we also introduce algorithms to reconfigure the schedules and routes when a link in the network is disconnected. The results are illustrated in a numerical example.

In the third part, we consider event-based feedforward control from a wireless disturbance sensor. We derive stability conditions when the closed-loop system is subject to actuator saturation. Feedforward control with anti-windup compensation is introduced to reduce the effect of actuator saturation. The effectiveness of the approach is illustrated in some numerical examples.