Networked Control Systems: Protocols and Algorithms

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Network Control Systems (NCSs) are spatially distributed systems in which the communication between sensors, actuators and controllers occurs through a shared band-limited digital communication network. The use of a multi-purpose shared network to connect spatially distributed elements results in flexible architectures and generally reduces installation and maintenance costs. Consequently, NCSs have been finding application in a broad range of areas such as the automotive and aerospace industries, mobile sensor networks, remote surgery, automated highway systems, and unmanned aerial vehicles.

The interest in NCSs has been steadily rising due to several factors:

- Low-cost, low-power, small embedded processors are widely available, which permits endowing sensors and actuators with local processing and sophisticated network protocols.
- Low-power, high-bandwidth digital communication is widely available to interconnect a large number of sensors, actuators, and controller nodes.

Inexpensive computation and ubiquitous embedded sensing, actuation, and communication provide tremendous opportunities for societal impact, but also great challenges in the design of networked control systems, because the traditional unity feedback loop that operates in continuous time or at a fixed sampling rate is not adequate when sensor data arrives from multiple sources, asynchronously, delayed, and possibly corrupted.

In this talk we review some of the challenges involved in closing feedback loops over communication networks. Our focus will be on issues related to variable sampling, delays, drops, and medium access control/scheduling. A key point that we would like to make is that networked control applications can profit significantly from the development of communication protocols specific for these systems.