

Networked Control Systems Research Challenges

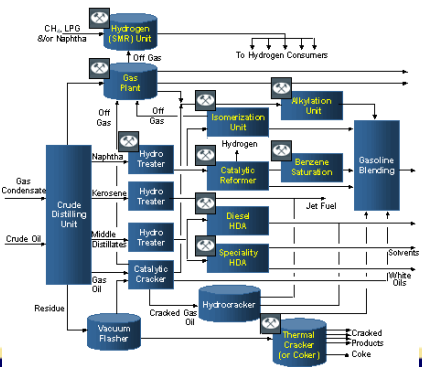
Panos J. Antsaklis

www.nd.edu/~pantakl

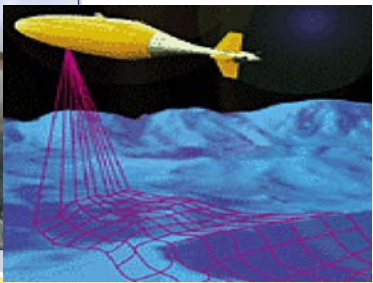
Introduction: Networked Control Systems

- Spatially distributed control systems have existed for decades.
Centralized decision making with wired connections.
- Technology driven-Low cost processing at remote locations and shared digital networks, wireless.
- Two main changes in control systems analysis and design.
 - A new component. The effect of **the Network**.
Shared communication channels. Media Access.
Delays. Dropped packets.
Fading. Time varying throughput.
 - Renewed emphasis on **Distributed Control**
Potential for superior performance.
Loosely interconnected clusters of control systems.

Networked Control Systems



UAV's operating together



Progress in Control Fundamentals

- Effect of quantization in feedback loop
min average bit rate for stabilization.
- How often feedback information is needed. Packets.
- Re-examination of open vs feedback control.
- Model-based control ideas.
- Issues brought to the forefront. Constrained control action.
- Emphasis has been primarily on single loop and stability.
- At the intersection of control, communications, computers.
Connections to information theory and computer science.

Progress

- Cooperative Control
 - Spatial invariance.
 - Graph theory
- Challenge is to consider channels that fade, disappear, re-appear.
- Consensus problem. Fixed and time-varying links. Focus on topology.

- Sensor networks research. Need sensor and actuator networks.
 - Communication protocols for scheduling and routing for stability, performance, reliability. Delays, delays.
- Real-time computer systems research. Able to deal with significant continuous dynamics.
- Algorithms and software. Motes. TinyOS, SOS (Neclab)

Collections of Reported Progress

- Special Issues on **Networked Control Systems**:
Proceedings of the IEEE, January 2007.
IEEE Trans. on Auto. Control, September 2004. **(PA & JB)**
- **Networked Embedded Sensing and Control**, *Proceedings of Workshop NESC'05, University of Notre Dame*, LNCIS 331, Springer 2006. **(PA & PT)**