

Lecture 14: Summary and outlook

Goals

- Review recent technology trends and control applications that **motivate** event-based control
- Provide an **overview of basic tools** from control and systems theory useful for further studies and research
- **Review recent results** in event- and self-triggered control, influence of wired and wireless networks (scheduling, packet loss etc), event-triggered model predictive control, distributed event-triggered control, applications for event-triggered control
- Discuss **open research problems** and emerging applications

Outline

- Lecture 1:** Event-triggered control
- Lecture 2:** Self-triggered control
- Lecture 3:** Hands-on simulations
- Lecture 4:** Miscellaneous, e.g., self-triggered control over CAN
- Lecture 5:** Output-based event-triggered control
- Lecture 6:** Robustness issues and event-separation properties
- Lecture 7:** Model-based event-triggered control
- Lecture 8:** Performance and self-triggered LQR
- Lecture 9:** Self-triggered MPC and roll-out event triggered control
- Lecture 10:** Stochastic event-triggered control
- Lecture 11:** Event-triggered control over wireless networks
- Lecture 12:** Distributed and saturated event-triggered control
- Lecture 13:** Applications
- Lecture 14:** Summary and outlook

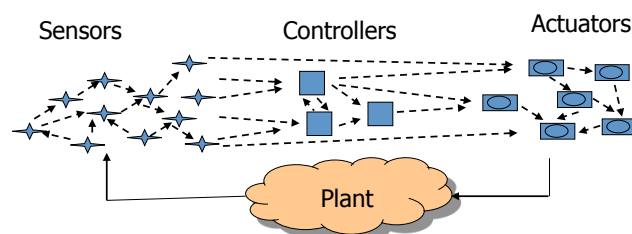
What was not covered?

- Discrete-event systems
- Detection theory
- Optimal stopping
- Aperiodic sampled systems
- Multi-rate sampled control systems
- Real-time systems and resource scheduling
- State synchronization
- Etc

Outlook and discussions

Wireless control system

How to share common network resources while maintaining guaranteed closed-loop performance?



Idea: Utilize event-based control to limit the use of network resources

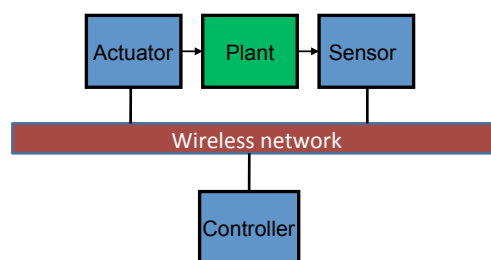


A communication, computing or control problem?

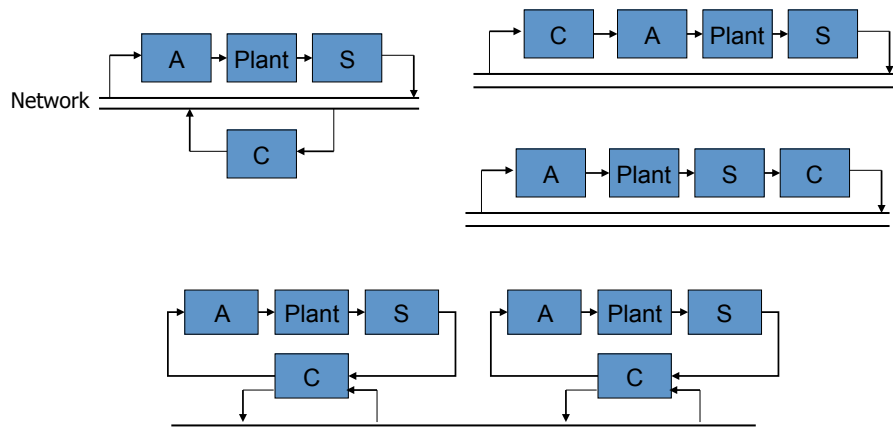
Approaches to networked control:

1. Communication protocol suitable for control
2. Controller that compensates for computing and communication imperfections
3. Integrated C3 co-design

Control Application
NET
MAC
PHY

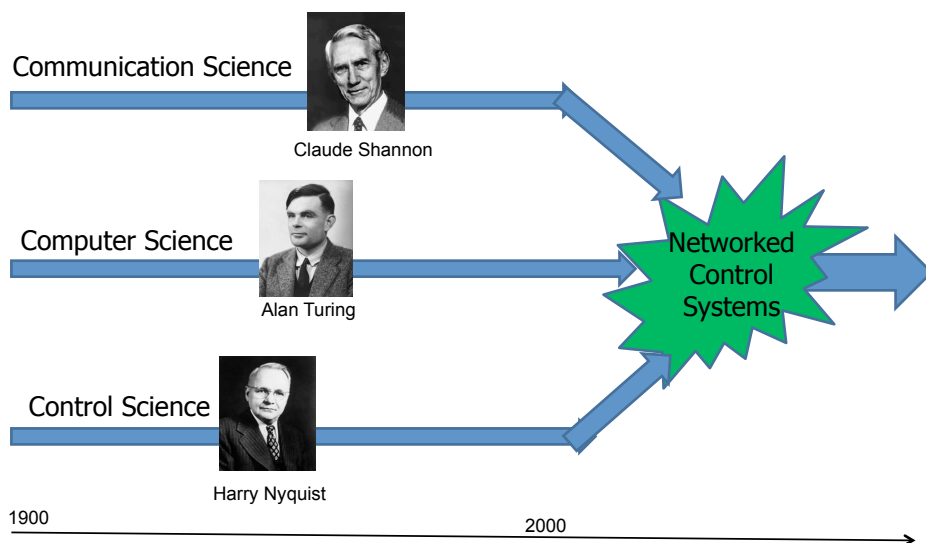


Some networked control architectures



Which are the implications for event-based control?

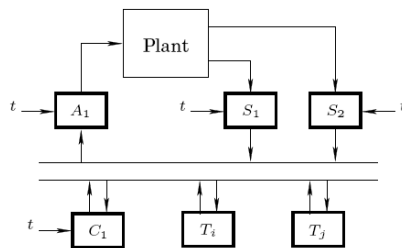
Convergence of Disciplines



A fundamental challenge in control

A conflict between

- time-driven, synchronous, sampled data **control engineering** and
- event-driven, asynchronous, ad hoc **wireless networking**

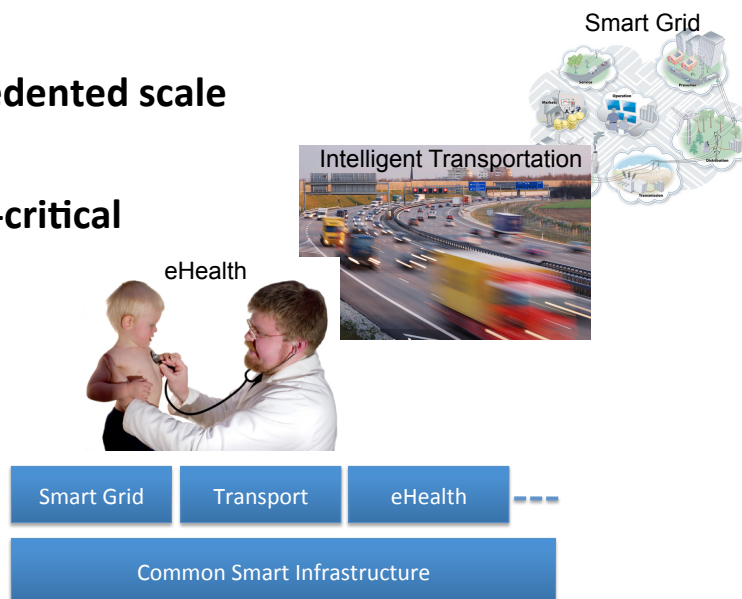


Characterstics of Cyber-Physical Control Systems

Unprecedented scale

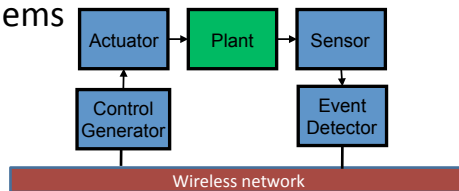
Mission-critical

Trusted



Conclusions

- Wide range of emerging wireless control applications
- Event-based control to support asynchronous networking – “If it ain’ t broken, don’t fix it” [Åström]
- Event-based control architecture allows network nodes to take local decisions
- Event detector and control generator design leads to interesting theoretical problems



<http://www.ee.kth.se/~kallej>

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Some other applications

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