# Action Webs MIT Berkeley

#CNS-0931843







# Hybrid and Embedded Systems

- Blending physics-based models with data
- Optimization-based inference for temporally evolving Boolean networks
- Event-driven computation

#### Tasking Sensors

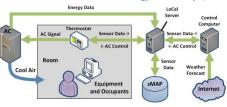
- Development of sMAP
- Reachability-based method for tasking sensors
   Estimating time-varying sensor reception
- Sensor scheduling and placement

#### Closing the Loop

- Advances in robust model predictive control (MPC)
- MPC with learning in the loop
- Optimization of hybrid systems
- Timing and event-driven computation [I]

## **Energy Efficient Buildings**

# Berkeley Retrofitted and Inexpensive HVAC Testbed for Energy Efficiency (BRITE) [2]





- Learning-based MPC [3] compensates for occupancy
- Heating load computed using only temperature sensor
- 30-70% energy savings in experiments
- Framework for demand-response

#### Simple Measuring and Actuation Profile (sMAP) [4]



- Interfaces sensors and legacy infrastructure
- IT enables energy saving applications

#### ActionWeb of Buildings



- Integrate diverse sources of physical and human generated information
- Augment sources to meet efficiency goals

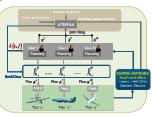
# Energy Efficient Air Transportation

# NextGen Air Transportation as Sensing and ActionWeb of Aircraft

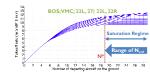


Real-Time Sensing and Decision Support

- From verbal information sharing to "sensing and action web" in the sky
- · Hierarchical structure with interacting layers



### Surface Congestion Management: Pushback Rate Control [5]



• Departure runway throughput "saturated" when pushback N greater than N\*

Date		Time Period	Configuration	Avg. gate-hold (min)	Total taxi time savings (min)
1.	8/26	4.45-8PM	27, 22L   22R	4.06	257
2.	8/29	4.45-8PM	27, 32   33L	3.24	114
3.	8/30	5-8PM	27, 32   33L	4.75	38
4.	9/2	4.45-8PM	27, 22L   22R	8.33	295
5.	9/6	5-8PM	27, 22L   22R	2.21	42
6.	9/7	5-7.45PM	27, 22L   22R	2.09	23
7.	9/9	5-8PM	27, 32   33L	2.18	24
8.	9/10	5-8PM	27, 32   33L	3.70	210
Total		24.5 hrs		4.35 min	16.7 hours

Field tests at BOS controlled the rate at which aircraft push back from gates

#### Runway Planning [6]





Solved using hybrid optimal control

#### Decentralized EnRoute Planning [7]



 Minimize individual decentralized costs subject to central regulation rules

#### Selected Publications

Maic, Edoon, and Lee, "PTIDES Model on a Distributed Testabe Emulating Smart Grid Real-Time Applications," in IEEE Conference on Innovative Smart Grid Technologies, 2011. To appear.

Aswam, Hasser, Timejs, Culled and Tomini, "Reductive granteen: and statedy state electricity companion in HVAC using learning-based model predictive control," Proceedings of the IEEE, 2011. To appear.

Aswam, Gonzales, Sastry, and Tomini, "Provably sale and robust learning-based model predictive control," 2011. Submitted.

Jang, Dawson-Haggerty, and Culler, "sMAP: simple monitoring and actuation profile," in ACMIEEE International Conference on Information Processing in Sensor Networks, pp. 374-375, 2010.
Simalakis, Khadilkar, Balakrishnan, Reynolds, and Hansman, "Demonstration of reduced airport congestion through pushback rate control," in USA/Europe ATM R&D Seminar, 2011.

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