

# Optimal decision making under communication constraints

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# A bit about my research

- High-level description**
- ▶ Decision making under uncertainty.
  - ▶ Sequential decision making in multi-stage systems.
  - ▶ Decision making in distributed and decentralized systems.

- Research areas**
- ▶ Stochastic control
  - ▶ Resource allocation
  - ▶ Artificial intelligence
  - ▶ Game theory/team theory
  - ▶ Operations research
  - ▶ Queuing theory

- Application areas**
- ▶ Networked control systems
  - ▶ Communication networks
  - ▶ Sensor networks
  - ▶ Electricity networks
  - ▶ Cloud computing
  - ▶ Medical treatment scheduling

- Conceptual questions**
- ▶ Trade-off between estimation, control, and communication.  
better current performance, better future performance,  
vs better performance for others.
  - ▶ Online learning in dynamical systems.  
how to help my future self to learn better

# Research projects relevant to CISCO

## Admission control in streaming of smart sensing measurements

Selectively drop packets to reduce the network load  
without adversely affecting higher layer application

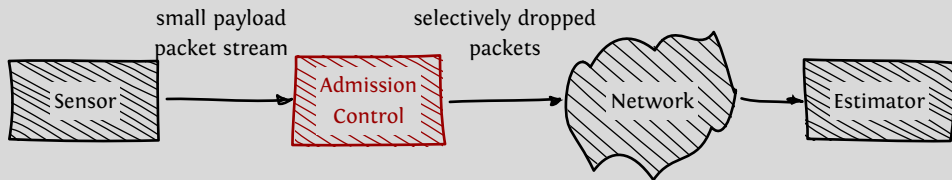
## Bandwidth efficient distributed anomaly detection

Communicate local events to help other nodes in detecting anomalies  
without flooding the network with diagnostic information

## Decentralized sequential hypothesis testing

Algorithms for decentralized sensing in smart buildings and cognitive radios.

# Admission control in steaming of smart sensing measurements



**Objective** Choose admission control protocol to  
minimize  $\#(\text{transmissions}) + \text{estimation error}$

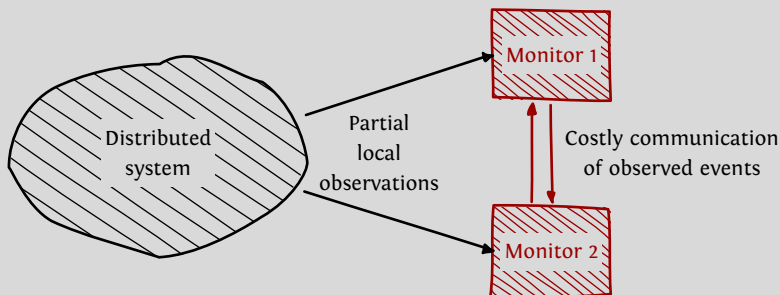
**Salient Features**

- ▶ Trade-off between network load and quality
- ▶ Receiver is oblivious to active dropping of packets
- ▶ A tunable parameter to control the fraction of dropped packets.

**Research questions**

- ▶ Can we do better than randomly dropping a fraction of packets?
- ▶ Drop less informative packets? How to identify such packets?
- ▶ Introduces a coupling between application and data layers. How to build a modular network for smart sensors?

# Bandwidth efficient distributed anomaly detection



**Objective** Choose **monitoring and communication protocols** that **minimize diagnostic traffic while ensuring anomaly detection**

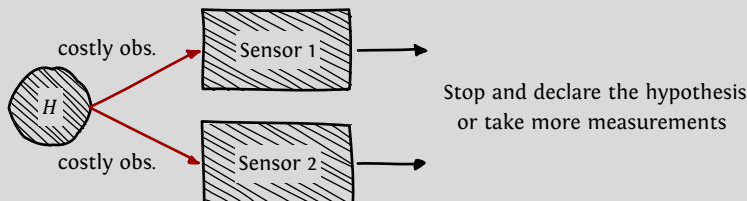
**Salient Features**

- ▶ Communicating **all events** floods network with diagnostic info.
- ▶ Only comm. **critical events** leads to delayed or missed diagnosis.

**Research questions**

- ▶ Verify the correctness of a protocol
- ▶ Systematic way to **synthesize** the protocol with smallest communication overhead

# Decentralized sequential hypothesis testing



**Objective** Choose **decision rules** to  
minimize obs cost + coupled false alarm/missed detection penalty

**Salient features**

- ▶ Based on limited observations, take a decision right now or take a costly measurement and then take a more informed decision in the future.
- ▶ Correlated obs and coupled stopping penalty across sensors.

**Research questions**

- ▶ How does performance depend on the quality of sensors?  
E.g., two medium quality sensors vs one good and one bad sensor.
- ▶ Trade-off between measurement cost and stopping time.