Learning in Networks

Devavrat Shah

LIDS, MIT

Paths Ahead 2009

Sanjoy K. Mitter

- First meeting
  - April 05, 2004

- Inspiration, wisdom
  - Quotes that make gray day bright

- Thank you

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Networks
that can be engineered

- Communication
  - Internet, wireless access network

- Computation
  - Data centers or cloud computing

- Transportation
  - Road networks, power-grid

Networks
that can be engineered

- Primary goal : learning
  - *Right* operating point
  - With (very) limited information
  - Using (very) simple algorithms

Networks
that can be engineered

- Example
  - Medium Access

- Key challenge
  - Dynamics

Medium Access

"The only way to understand congestion, is to feel it !"

Balaji Prabhakar, Paths Ahead, Nov 14, 2009.

Medium Access

- Let's play a game
  - Reward : $1 (not €)

- Rules
  - Respond, when asked, in 10ms-20ms
  - No reward if
    - none, or more than one, responds
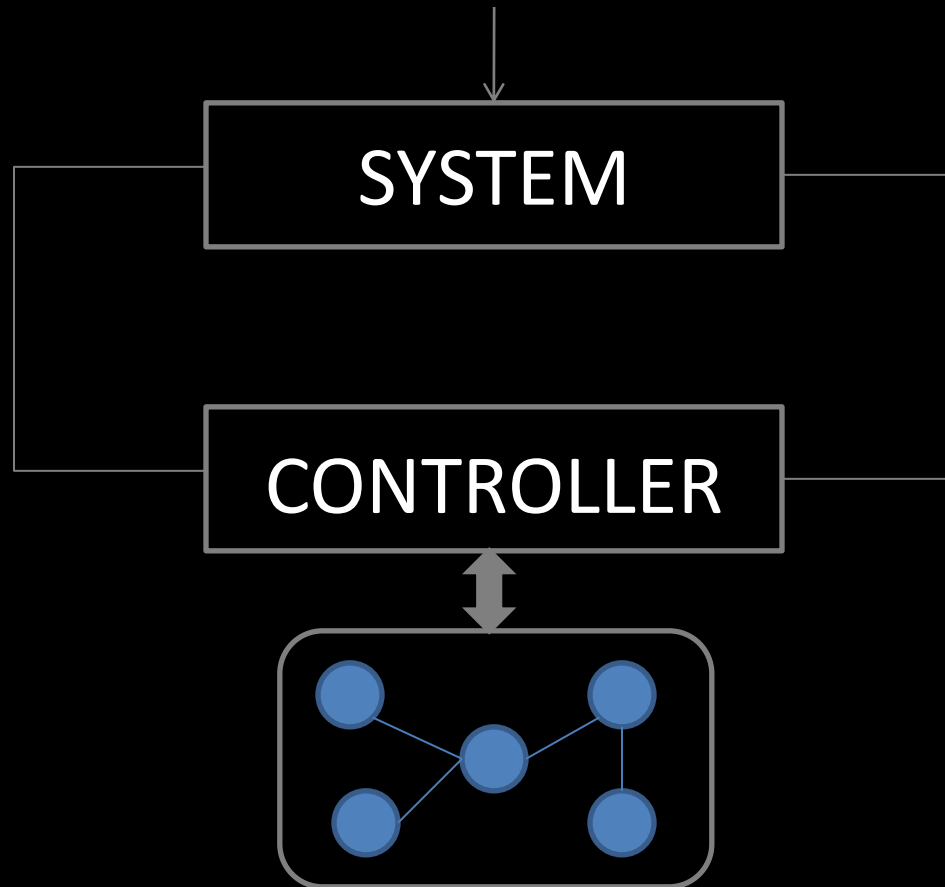 - Otherwise, the unique responder gets the $1

Medium Access

- Reaction time to auditory stimulus : 140-160ms

http://en.wikipedia.org/wiki/Reaction_time

Medium Access

- Learn the *right* medium access through
  - Response to attempts

- The problem is inherently information limited

- Kept communities busy for quite a few decades
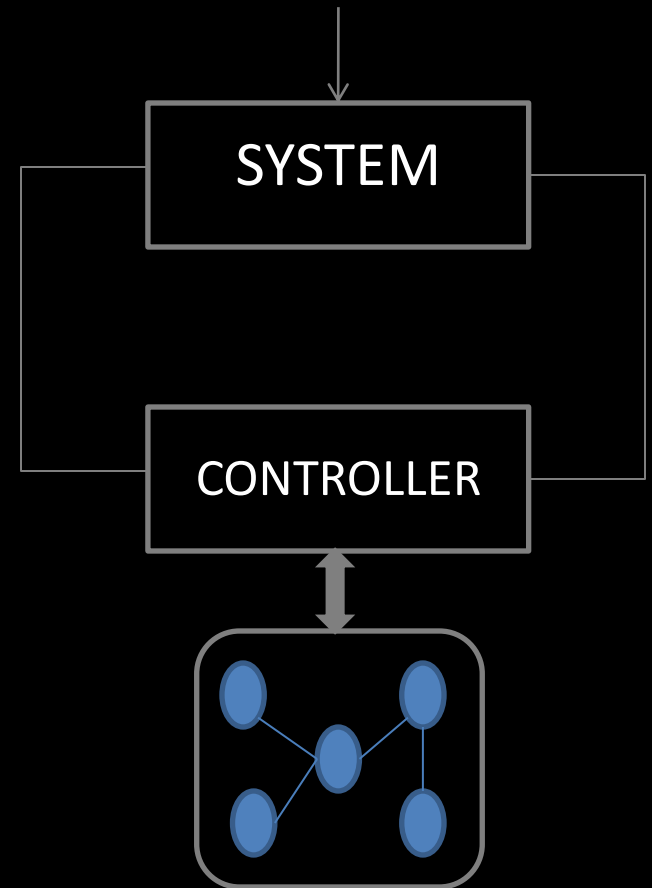
Medium Access

Medium Access

- Controller should solve

  - A variational problem

  - In distributed manner

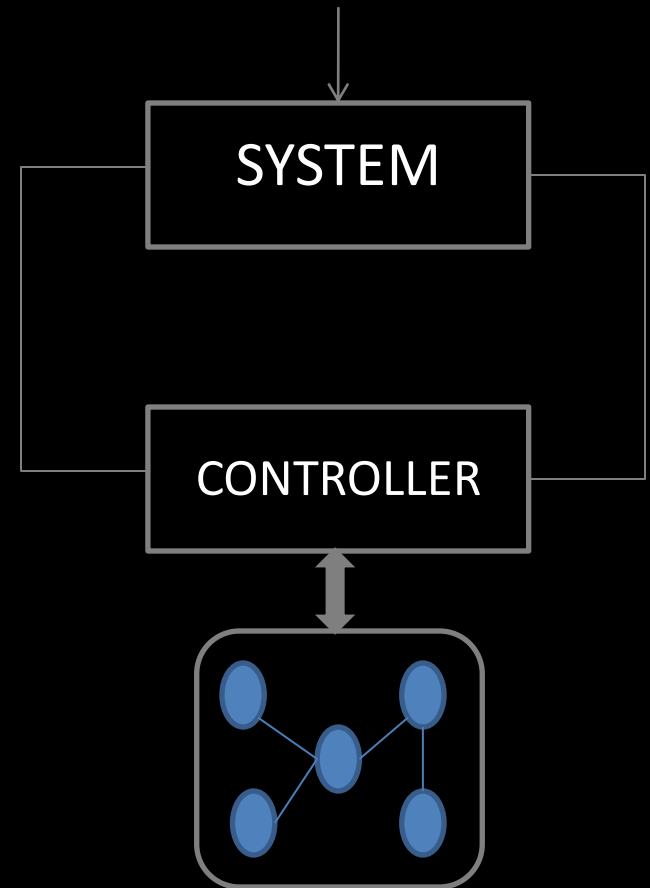 - Using limited info.

➢ Capacity achieving MAC
  (S & Shin 09)

| SYSTEM |

| CONTROLLER |
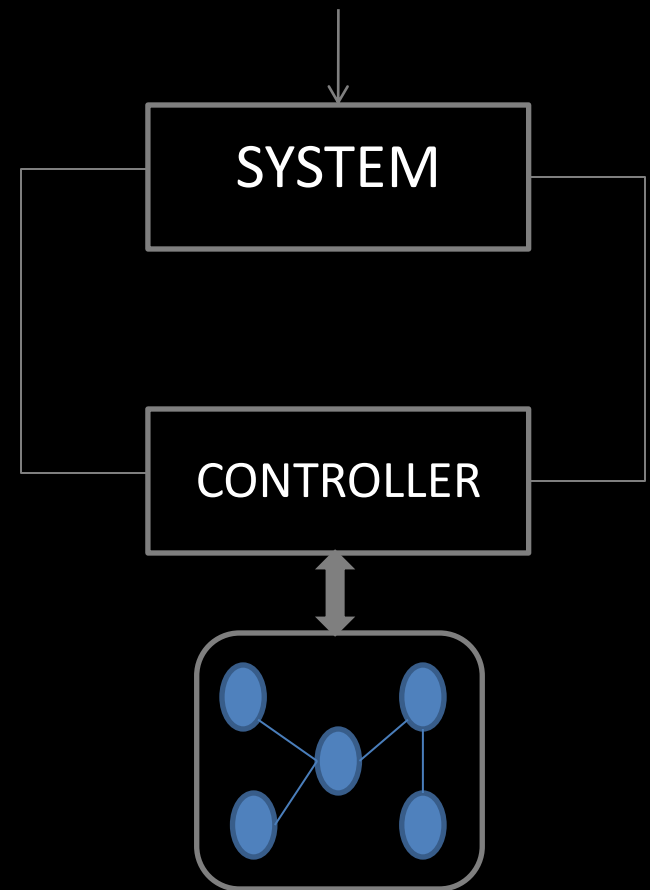
Medium Access: Going Forward

- Challenge: Dynamics in

  o Connectivity structure,
  or network topology

  o Nodes join/leave

  ➢ Need dynamics aware
  network design

Network Resource Allocation

- Challenge: Dynamics

  - ○ Medium access
  - ○ Routing

  - ○ ...

SYSTEM

CONTROLLER

Network Measurement

- Learn global network properties

  o Limited measurements, e.g.
    - End-to-end traffic from per link measurement

- Dynamics: traces over time

  o How to utilize time information/dynamics for better design?

Summary

- ## Learning view for network design
  - Dynamics aware algorithms

- ## Model prediction
  - Using underlying dynamics