ALGORITHMS & OPTIMIZATION

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An optimal Architecture

Increase/Decrease data injection rate depending on ingress queue length (not end-to-end congestion)

Source

Ingress Queue length

20
60
80
20

Weights= -40 -20
Backpressures

60

Backpressure algorithm: Allocate resources to maximize the weighted sum
Assumption:
- Treat interference as noise
- Link rate = \log(1+\text{SINR})

Power control w/o time-sharing
- Convex optimization theory and calculus
- Gradient algorithms
- Simple to analyze, but loss in capacity; how much?

MAC a.k.a. time-sharing
- Only two power levels: zero and max
- Network is a graph
- Combinatorial optimization
- Very hard: approximations, worst-case results can be quite bad; average case?

Capacity region w/o time-sharing vs.
Capacity region after Time-sharing
Experience suggests that convex optimization-based solutions are easy to implement in a distributed manner.

Combinatorial solutions are difficult to decentralize; resort to approximations.

Are there other modes of operations that can “fill” out the capacity region without using time sharing?

- Can new PHY layer approaches make the problem more amenable to distributed solutions at the MAC/network layers?
Other Challenges

- Limits of performance of networks with elastic flows are well-understood
  - Combination of rate control and hop-by-hop congestion control

- What about inelastic or semi-elastic flows?
  - Admission control
  - Delay requirements in addition to data rate requirements
  - Non-convex problem