Using Distributed Algorithmic Mechanism Design (DAMD) to Control Mobile Ad-Hoc Networks

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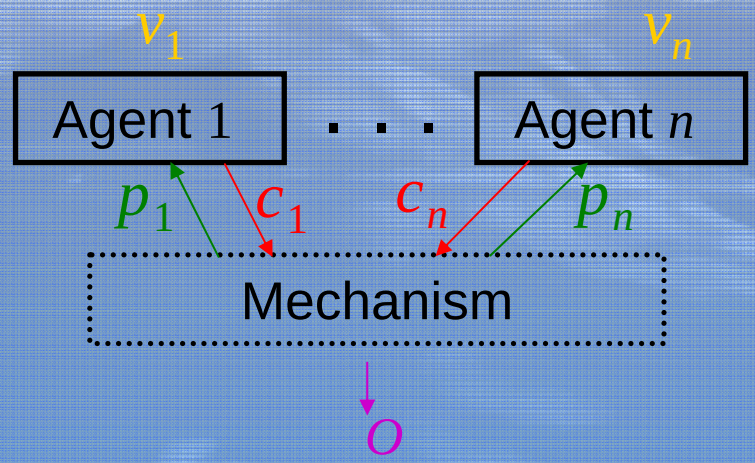
Distributed Algorithmic Mechanism Design (DAMD)

What is it and why is it relevant to CBMANET

- An emerging field at the intersection of computer science, game theory, and large-scale distributed computing
- The objective of DAMD is to achieve system-wide goals without centralized control and communications, with low computational and message complexity, considering agent's incentives.
- Three components
  - System-wide goals, e.g., missions, efficiency and fairness goals, defined by a subset of all possible outcomes
  - Each agent has a (privately known) valuation for each outcome. It may have multiple *conflicting* individual goals, e.g., transmit now or conserve energy.
  - The (distributed) mechanism computes an optimal outcome and motivates agents to cooperate by charging or providing "payments."



Example: Incentive-Guided Distributed Optimization

Individual vs Group

Some nodes may choose to operate as relays on behalf of others with less battery life

App. vs App.

High data applications such as video compete for limited bandwidth.

video

text

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Ind. vs Ind.
(General vs 1st LT)

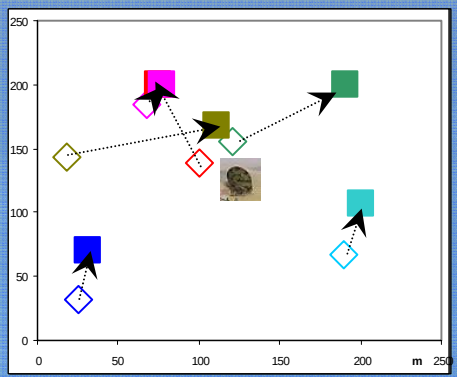
Seniority and the need for time critical information dictate network resource allocation

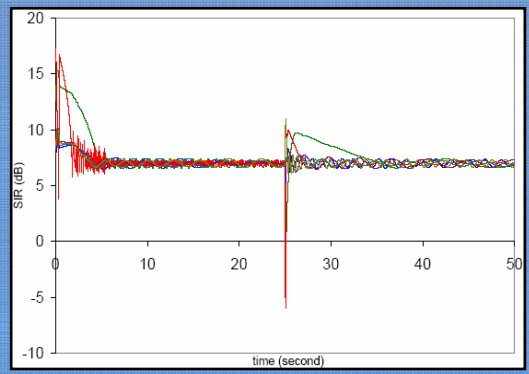
Nodes exchange messages to update link "prices", which signal contention for resources.

Node vs Node

Never deny network access due to friendly interference: Spectrum Management and Power Control

Nodes locally determine configuration parameters according to task, budget, and resource "prices".





Network guided distributed optimization is a primal-dual algorithm which performs distributed optimization by decomposition according to network structure. It explicitly models relationships and constraints among configuration parameters, and then maximizes aggregated transmission rate given the "preferences" of each session.

$$\text{Maximize} \sum_s \beta_s Sigmoid_s(x_s) - \alpha_s P_s$$

$$\text{Subject to} \sum_{s \in S(l)} x_s \le R_l \cdot b_l$$

$$SIR_s \ge \underline{\gamma}_s$$

Status and Teaming

- Current group at Yale: Joan Feigenbaum, Avi Silberschatz, Richard Yang
- Open to team up with other groups with complementary expertise