Application of Game Theory in Wireless Ad Hoc Networks

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Motivation and Goal
We model a Non-cooperative Game based framework to find a good balance between the two conflicting objectives. Allow nodes to learn operating point, by considering payoffs that reflect the behaviors and feedback of real network status.

Tradeoff

Optimal Points - Nash Equilibrium

The situation \( x_1^*, \ldots, x_N^* \) is called Nash Equilibrium in the Game \( G \), if for all nodes give strategies \( x_i \) and \( x_{-i} \), there is

\[ U_i(x_i, x_{-i}) \geq U_i(x_i^*, x_{-i}) \]

The equilibrium strategy under this is that the value of \( x_i \) that maximizes the \( U_i(x) \)

\[ U_i(x^*) = \max_{x_i} U_i(x_i, x_{-i}) \]

Evaluation Results

Non-cooperative Game Model

- **Player:** There are \( N \) nodes in the network
- **Utility Function:** \( U_i(x_1, \ldots, x_N) \)
  
  \[ U_i(x) = \alpha \cdot \sum_{j \neq i} x_j + (1 - \alpha) \cdot x_i \]

\( \alpha \) is normalized as packet generating rate by node \( i \), \( x_i \) is the strategy set.

Case I: Power Consumption

Case II: Delay in Own Data

Application Scenario

Optimal Points - Nash Equilibrium

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