Designing Incentives for Peer-to-Peer Routing

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Free Loading and Routing

- non cooperating users (file sharing)
- same issue for routing?
- more sensitive?

Kandori's Social Norm

- Iterated Prisoner's Dilemma with random matching
  - random opponent each round
  - Prisoner's Dilemma
- trusted reputation scheme
  - player $\leftrightarrow$ label
- Social Norm Strategy
  - both innocent $\Rightarrow$ both cooperate
  - both guilty $\Rightarrow$ both defect
  - one guilty one innocent $\Rightarrow$ guilty cooperate, innocent defects
- subgame perfect equilibrium

Routing

- routing is not symmetric
  - A asks B to route a packet
  - B can defect or cooperate
  - A does nothing
- routing model inspired by DHT's
  - Chord, Pastry, Tapestry, etc., multiple hops
  - average path length: $l = \frac{\lg(N)}{2} + \frac{1}{2}$
    - for $N = 1,024$ $l = 5.5$
  - cost of routing a packet: $c = -2$
  - "final prize": $p = Klc = 40$

Social Norm for the Routing Game

- $A \rightarrow B$
  - if A is innocent $\Rightarrow$ B cooperates
  - if A is guilty $\Rightarrow$ B defects
- requests generated at a constant rate
  - no big bursts
- punishment alternatives:
  - packet based
  - time based
- time based punishment chosen
- subgame perfect equilibrium under certain assumptions

Simulations (overview)

- what is the effect of:
  - malicious nodes?
  - network failures/dropped packets?
  - reputation system reliability?
- payoffs distribution?

Performance metrics

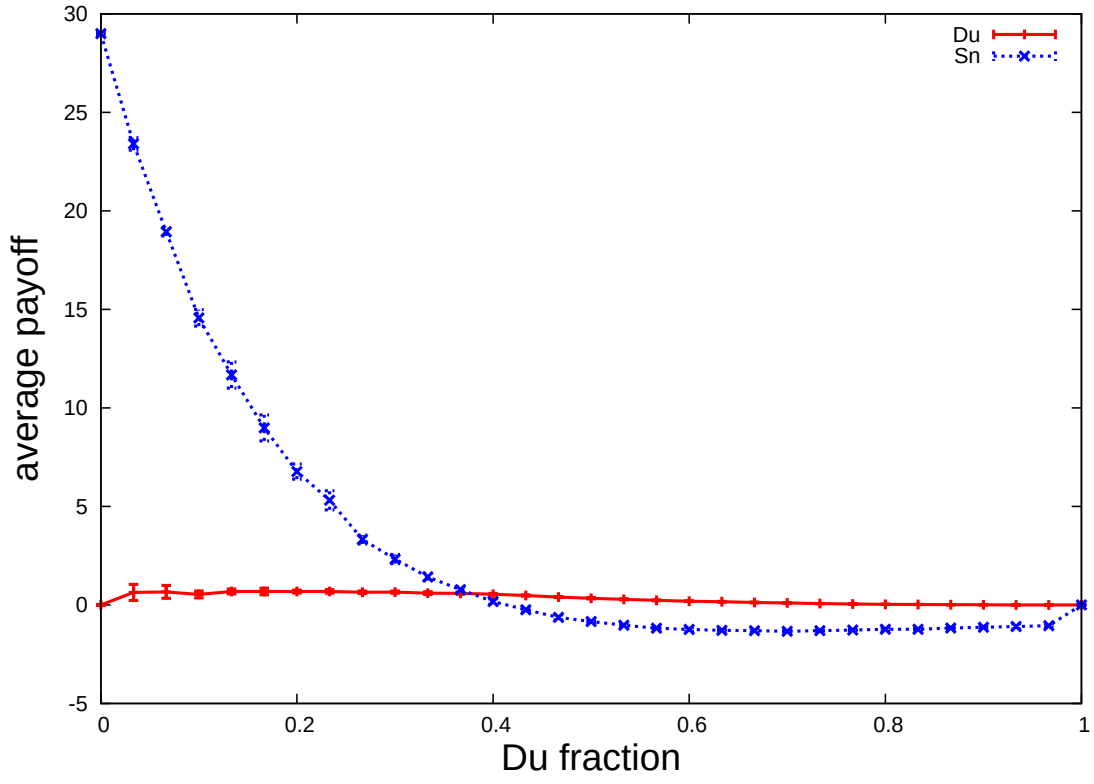
- average payoff per request:

$$\frac{\text{total payoff of all the players playing the strategy}}{\text{number of requests made}}$$

- efficiency:

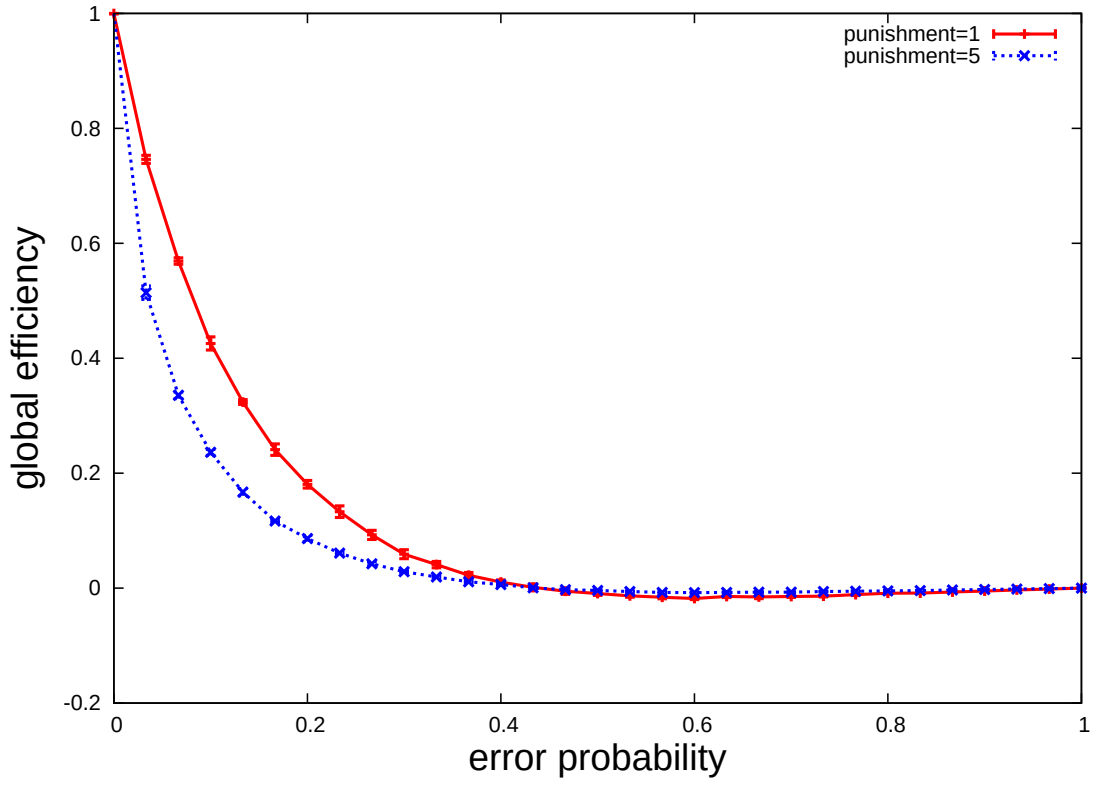
$$\frac{\text{total payoff of all the players}}{\text{total payoff if ALL requests succeeded}}$$

Malicious Nodes: average request payoff



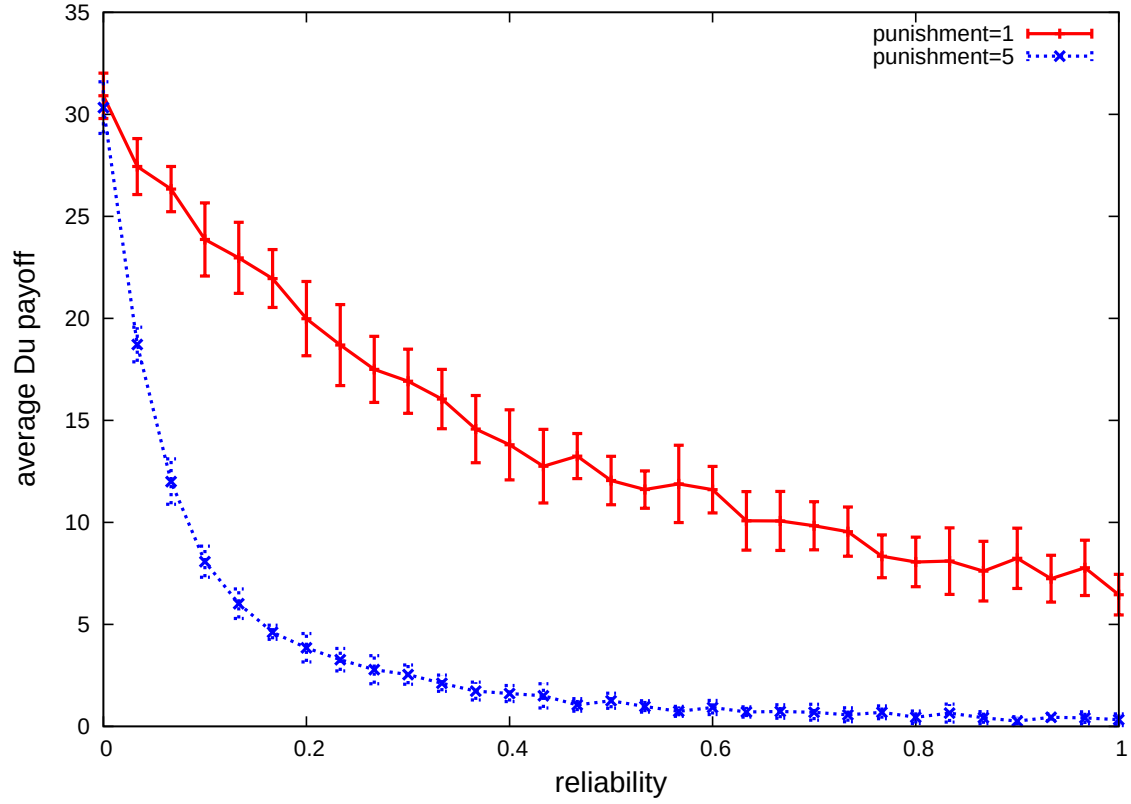
- reliable network and reputation scheme, punishment=2
- very small payoffs for Du nodes

Network Failures - Dropped packets



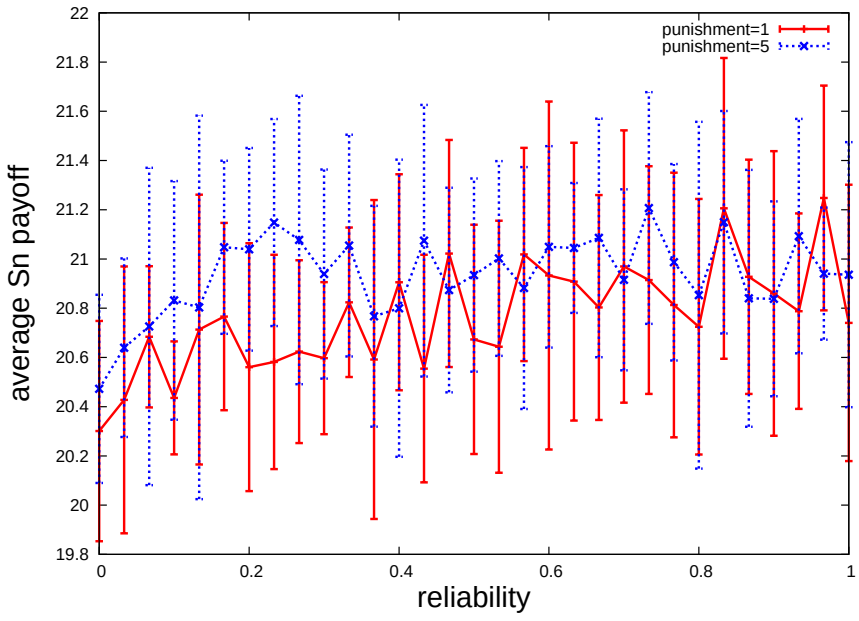
- only Sn players with perfect reputation scheme
- x axis: probability of loosing a single packet
- tradeoff in choosing punishment length

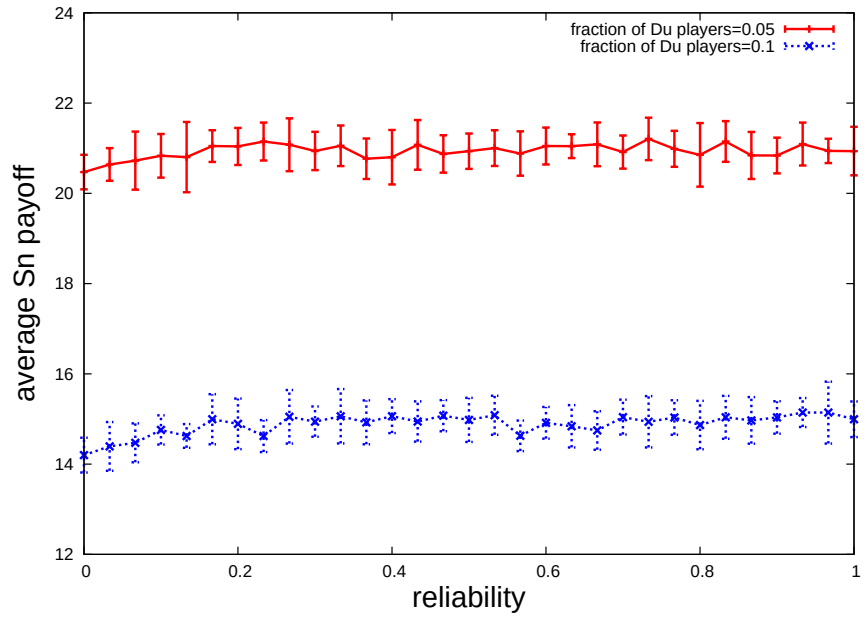
Reliability of the Reputation System



- 90% Sn players
- x axis: probability of being caught when dropping a packet
- punishment hurts Du nodes

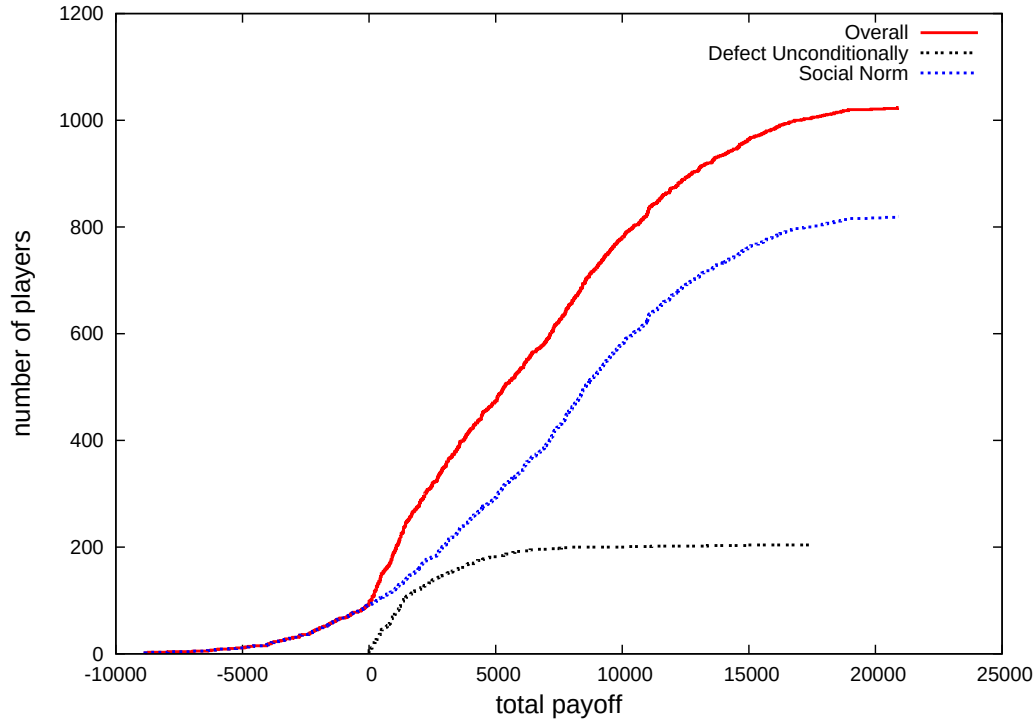
Reliability of the Reputation System





- 90% Sn players (left), punishment=5 (right)
- x axis: probability of being caught when dropping a packet
- almost constant Sn payoffs

Payoffs Cumulative Distribution



- reliability 20%, 80% Sn players, punishment=5
- x axis: total payoff at the end of the game
- negative payoffs for some Sn nodes
  - dynamically updating routing tables?

Open Issues: Strategies

- social norm randomized
- heterogeneous demand
- timing of requests

Open Issues: Reputation System

- implementation issues
- reputation tampering
- collusion
- cost of the reputation system

Conclusions

- Social Norm applies to asymmetric game
- investigated the effects of:
  - malicious nodes
  - network issues
  - reputation scheme
- some simplifying assumptions needed
- promising results