

Incentive Problems in Peer-to-Peer Systems

Xuanjia Qiu
Sept. 24, 2010

Outline

- Why are Incentive mechanism in need? Why is design of incentive mechanisms difficult?
- Classification of incentive mechanisms and examples
- Analytical tools
- Future research directions

Why incentive?

- Features of peer-to-peer:
 - decentralization(no single administrative entity -- different from distributed system)
 - collusion attack (users forming groups to maximize benefit)
 - high churn rate
 - availability of cheap identities -- whitewashing attack and sybil attack
 - hidden actions
 - care for performance (completely tit-for-tat is impossible)

Various incentive mechanisms

- Exchange-based:
 - BitTorrent
- Currency
 - Mojonation, Karma
- Reputation
- Others
 - SRE(Sharing ratio enforcement), Domain-specific, relating to Social Network
- Another method of classification:
 - Direct reciprocity and indirect reciprocity

BitTorrent

- Symmetric interest
 - Can not be used in streaming
- Exploit of BitTorrent
 - many free-riding software developed:
 - BitTyrant (link to more neighbors and adjust the upload bandwidth according to the marginal gain)
 - "Large View Exploit" (link to more neighbors to get more chance to be optimistically unchoked without upload anything)
- Exclusively relying on one's own direct observations do not make use of all the information available.

Reputation System

- More scalable than direct reciprocity systems, but rely on third party observations and must handle trust issues which are absent in the direct reciprocity systems.
- Extremely vulnerable to whitewash attacks and sybil attacks -- easy to clean bad reputation
- To deal with the trust issues:
 - "A Robust Reputation System for P2P and Mobile Ad-hoc Networks" proposes to track the *reputation ratings* and *trust ratings* of the neighbors.
 - But only limit the attacks rather than eliminate them.

Currency

- Real money?
 - Not system compatible
 - Online clearing need extensive infrastructure support
 - require money exchange at the rotocol's time intervals.
 - Legal issues
- Virtual money?
 - Virtual: have no value outside of the system
 - How to avoid double-spending? (a thrid party mediator)
 - How to decide price? how to elicit true valuation?
 - Example: Karma (DHT neighbors as "bank-set" and use auctions to decide price)
- Some one prove that optimal mechanisms typically involve money transfer.

Sharing Ratio Enforcement

- Idea:
 - Enforce each peer must maintain its sharing-ratio (uploaded bytes over downloaded bytes) above a threshold level
 - invitation to join in the system
- Solution to collusion attack:
 - Entropy

SRE (cont.)

- "SRE" may be viewed as a variated reputation system.
 - Similarity: indirect reciprocity, making use of indirect observation
 - Variation:
 - the reputation is not based on the counting of "response" or "refusal" to a request, but the amount of contribution and consumption
 - whether peer i cooperates with peer j depends on sharing-ratio -- when it drops below the threshold level, all the peers don't cooperate with it anymore because it is evicted from the system.
- Some thoughts:
 - Can SRE be used in a decentralized way in the live streaming?
Sharing the share-ratio information about a stranger among friends?

Domain specific solutions

- Binding the contribution with the QoS:
 - Peers bid for the level of service, such as the distance to the root in a broadcast tree
 - At the cost of decreased social good.

Relating to social network

- Example: NABT (networked asynchronous bilateral trading)
- Idea:
 - Peers set credit limits for its friends
 - Upload data when the credit balance is within the limits
 - Exchange credit when trade between friends of friends.

Analytical tools

Mainly borrowed from micro-economics:

- Game theory
 - IPD(also known as Tit-for-tat) (iterated prisoner's dilemma)
Game -- BitTorrent
- Mechanism design
 - Inverse game theory
 - Algorithmic mechanism design : a rigorous methodology to create games with a particular set of desired outcomes in mind.

Future research directions

- Satisfy:
 - Trade off between distributed (not totally distributed) and central support (simple)
- Associate social networks
 - more trust
 - the reported information is more reliable: record sharing ratio in a distributed way and share sharing ratio about strangers among friends
 - credit
- Cross overlay
 - Encourage peers that are not interested in downloading file A to help distribute file A



End

Thank you