

Market-Based Techniques in Diffuse Computing

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Two Views of Multi-agent Systems

CS

Focus is on
Computational &
Communication
Efficiency

Agents are
Obedient,
Faulty, or
Adversarial

ECON

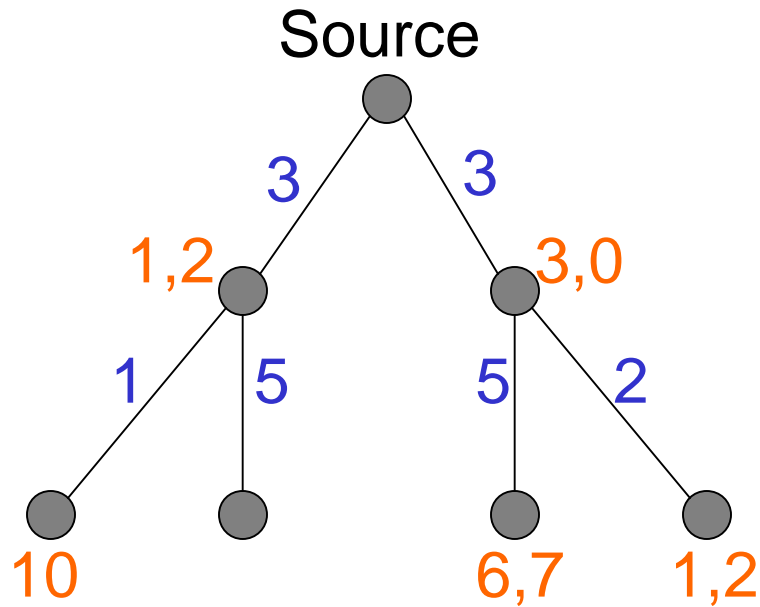
Focus is on
Incentives

Agents are
Strategic

Internet Computation

- Both **incentives** and **computational and communication efficiency** matter.
 - “Ownership, operation, and use by numerous independent self-interested parties give the Internet the characteristics of an **economy** as well as those of a **computer**.”
- ⇒ **DAMD: “Distributed Algorithmic Mechanism Design”**

Multicast Cost Sharing Mechanism-Design Problem



Users' types

Link costs

Receiver Set

Which users receive the multicast?

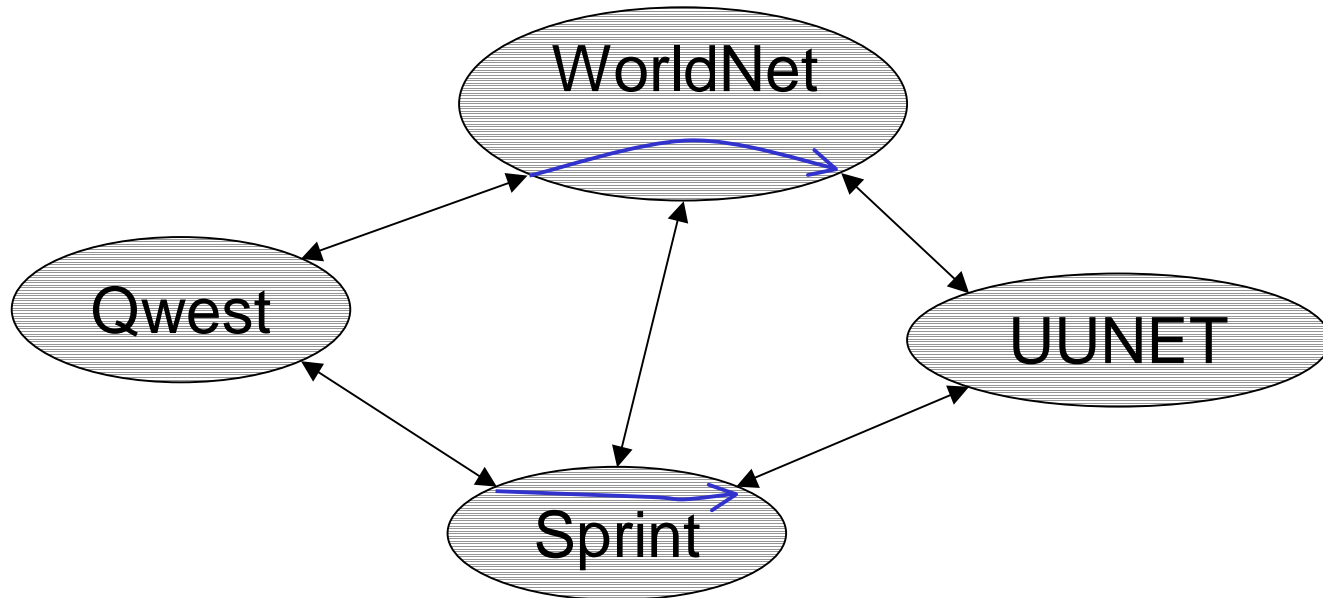
Cost Shares

How much does each receiver pay?

(Some) DAMD Results on Multicast Cost Sharing

- **Feigenbaum-Papadimitriou-Shenker [STOC '00]**
Welfare-maximizing mechanism has **good network complexity**.
- **Feigenbaum-Krishnamurthy-Sami-Shenker**
Budget-balanced mechanisms have **bad network complexity**.
- **Fiat-Goldberg-Hartline-Karlin [STOC '02]**
Under certain (plausible) market conditions, *competitive* mechanisms have **good network complexity**.
- **Mitchell-Teague**
Cryptographic techniques can be used to handle **strategic** or **adversarial** network behavior.

Lowest-Cost Routing Mechanism-design Problem



Agents: Transit ASs

Inputs: Transit costs

Outputs: Routes, Payments

Problem Statement

Agents' types: Per-packet costs $\{c_k\}$

(Unknown) global parameter: Traffic matrix $[T_{ij}]$

Outputs: $\{route(i, j)\}$

Payments: $\{p^k\}$

Objectives:

- Lowest-cost paths (LCPs)
- Strategyproofness
- “BGP-based” distributed algorithm

(Some) AMD Results on Lowest-Cost Routing

- **Nisan-Ronen [STOC '99]**
 - Polynomial-time centralized mechanism
 - **Strategic** agents are the edges.
 - Single source-destination pair
- **Hershberger-Suri [FOCS '01]**
 - Same formulation as in NR'99
 - Compute **payments** for *all* edges on the path in the same time it takes to compute **payment** for *one* edge
- **Feigenbaum-Papadimitriou-Sami-Shenker [PODC '02]**
 - **BGP-based, distributed algorithm**
 - **Strategic** agents are the nodes.
 - All source-destination pairs