
Accountability and Resource Management

A discussion of issues
for peer-to-peer systems

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Managing scarce resources...

- Freenet: unpopular data is dropped; popular data is cached near the requester
- Gnutella: data is stored only on the publisher's own computer
- Publius: currently limits submissions to 100K

Introducing accountability...

- Mojo Nation: micropayments are used for all peer-to-peer exchanges
- Free Haven: reputation system – publishers must provide reliable space of their own
- Mixmaster: statistics pages track uptime

Discussion outline

- Accountability problem
- Current systems
- Models of P2P systems
- Resource management techniques
 - Electronic payments
 - Reputation systems
- Conclusions

The resource management problem

- Goal: maximize a peer's *utility* to the overall system while minimizing its potential *threat*.
- Threat: peers eat resources
- Accountability
 - Approach to resource management
 - Resources more efficient and protected

Why is P2P accountability hard?

- Tragedy of the commons
- P2P discourages permanent public identification
- Hard to assess peer's history or predict future performance
- Legal contracts are outdated and impractical

Problems to tackle

- Intentional attacks (adversaries) and simple overuse (freeloaders)
- User attacks
 - Communication DoS (query flooding)
 - Storage flooding
 - Computational overload

Problems to tackle

- “Server” attacks – low-quality service
 - Dropping data
 - Providing corrupted data
 - Ignoring requests
 - Going down when needed
 - Adversarial collusion

...not following system protocol !

Problems in current P2P systems

- Freenet
 - Bandwidth overuse (query flooding)
 - Cache flushing (data flooding)
- Gnutella
 - Vulnerable to query flooding
 - Freeloading
- Publius
 - Public server identities:
directed attack on bandwidth, storage space

Problems in current P2P systems

- Mojo Nation
 - How to set prices?
 - Performance tracking, not reputation
- Free Haven
 - Very vulnerable to query flooding
 - Protected against data flooding
(reputation system is complex and untested)
- Mixmaster
 - No verifiability
 - Uptime is not reliability

Two accountability solutions

- Restrict access to resources
 - Digital payment mechanisms

- Select favored users
 - Reputation schemes

P2P models

1. Static, identified operators

- Examples: Mixmaster remailer, Publius
- Limited users: legal mechanisms possible
- Reputation and payment schemes

2. Dynamic, identified operators

- Examples: Gnutella, Freenet, Mojo Nation
- Reputation and payment schemes

P2P models

3. Dynamic, pseudonymous operators

- Example: Free Haven
- Reputation and payment schemes
 - Decisions may be based on prior behavior

4. Dynamic, anonymous operators

- Payment schemes only
 - All information is ephemeral
 - Decisions based only on current transaction

Goal of payment schemes

- Manage scarcity of resources
 - Charge for access
- Prevent intentional attacks
- Restrict freeloading
- Result: optimize for “social efficiency”
 - Users contribute to overall system robustness

Payment schemes: models

- Proofs-of-Work (POWs)
 - Examples: hash cash, Client Puzzles
- Fungible non-anonymous payments
 - “Credit cards”
 - Examples: MicroMint, PayWord, Millicent, Mondex
- Fungible anonymous payments
 - “Cash”
 - Examples: Chaum’s eCash, Brands’ digital cash

Congestion management

- Temporary resource allocation
 - Determine need dynamically
 - Areas: bandwidth, computation, caching
 - *Solution? Only charge when congested*

- Cumulative resource allocation
 - Once allocated, not easily recoverable
 - Area: persistent storage
 - *Solution? Always charge*

Reputation systems

- Track performance to predict future behavior
- Risk resources based on anticipated benefit
- Information provided by third parties

Example reputation systems

- PGP Web of Trust
- Slashdot, Advogato
- Free Haven, Mojo Nation
- Amazon, eBay
- Google, Clever

Some goals for reputation systems

- Local / personalized reputation
- Resist pseudospoofing
- Resist shilling, e.g., verify transactions
- Collect enough data to be useful
- Distinguish between reputation and credibility

Accountability slider

- Dynamically determine need and extent
- Digital payments
 - Adjust “amount” charged
- Reputation systems:
 - Adjust “trust” thresholds

Conclusion

- Peer-to-peer won't save you
- Accountability is not pixie dust
- Payment and reputation systems are efficient and flexible solutions
- Verifying behavior still necessary
- Convenience trumps accountability...

Further reading...

*Peer-to-Peer:
Harnessing the Power of Disruptive
Technologies*

Chapter 16: Accountability

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