
BitTorrent is an Auction: Analyzing and Improving BitTorrent's Incentives

Dave Levin University of Maryland
SIGCOMM'08

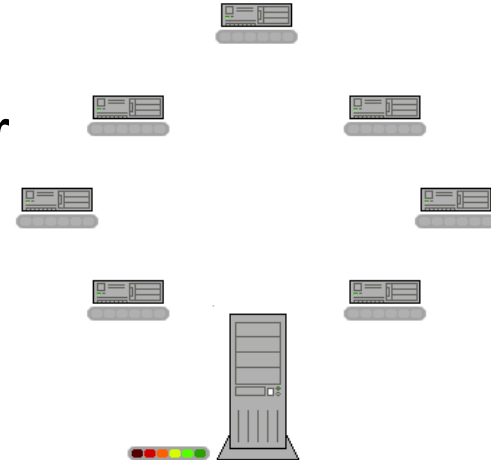
Presented by Wenxuan Zhou

Outline

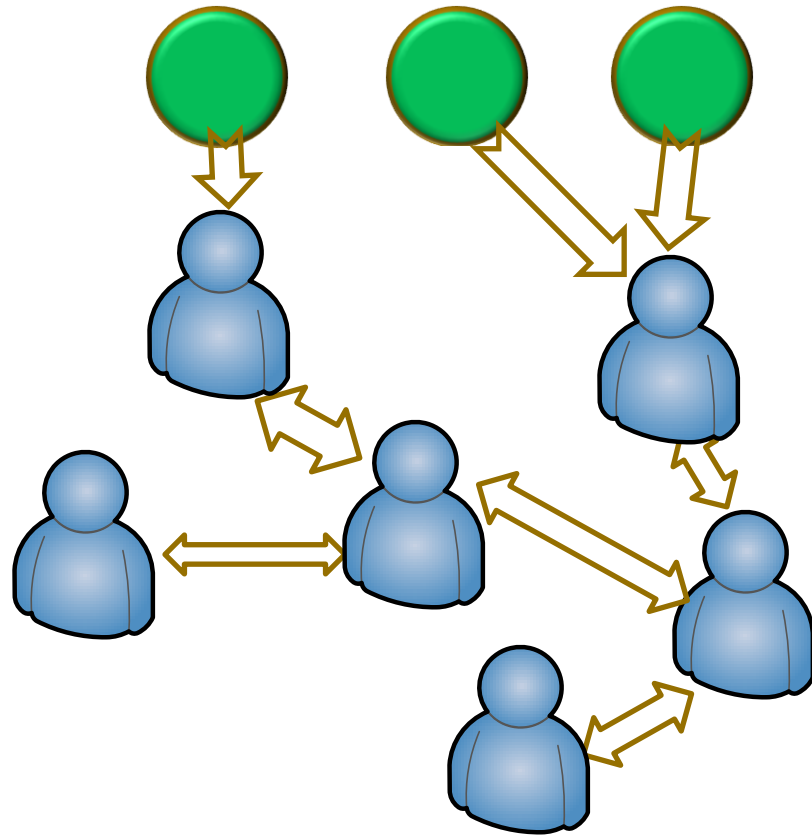
- ■ BitTorrent Primer
 - “BitTorrent is an auction”
 - Model BitTorrent as an auction
 - Proportional share
 - Under-report block revelation
 - Related Work
-

BitTorrent

- Written by Bram Cohen (in Python) in 2001
- A peer-to-peer file sharing protocol, “Pull-based” “swarming” approach for distributing large amounts of data
 - Nodes request desired pieces from neighbors
 - Each file split into smaller pieces
 - Pieces not downloaded in sequential order
- Swarm
 - Set of peers downloading the same file
 - Organized as a random mesh

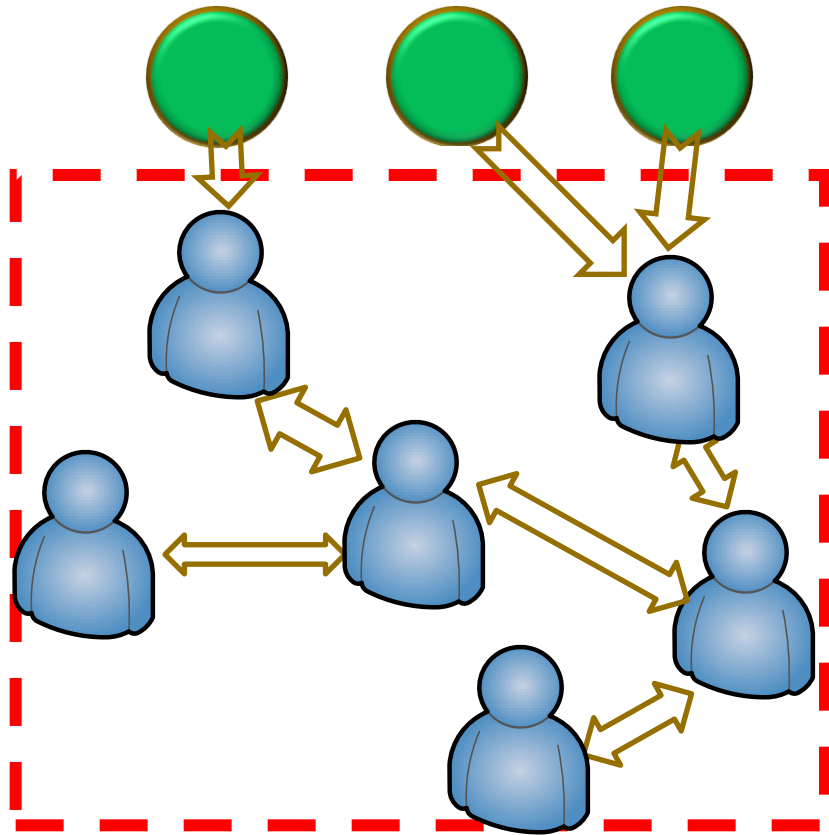


BitTorrent



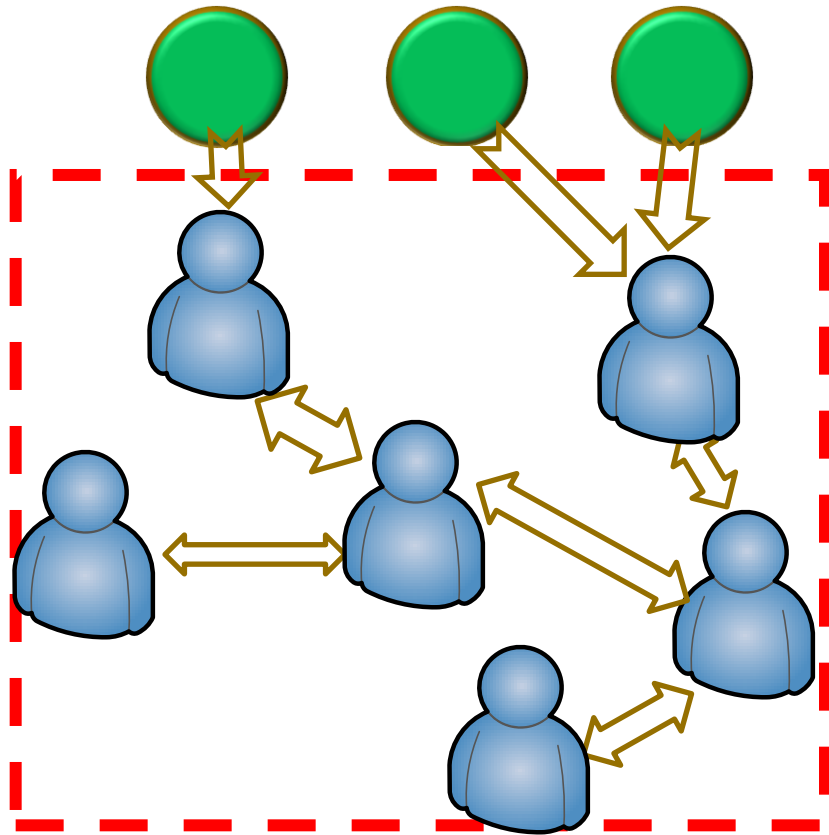
- Seeders upload
- Leechers trade
- Trackers introduce

BitTorrent



- Seeders upload
- Leechers trade selfish
- Trackers introduce

BitTorrent



- Leechers trade selfish

Need incentives to encourage contribution by all nodes

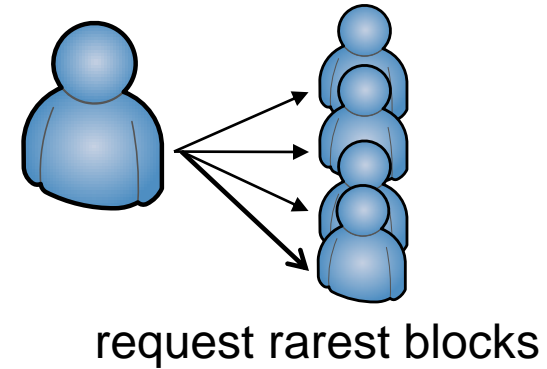
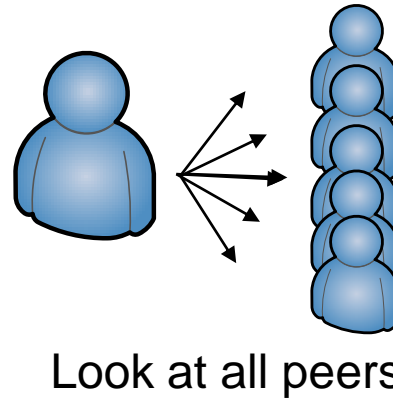
Lifecycle of a Leecher



Leechers' Local Policy

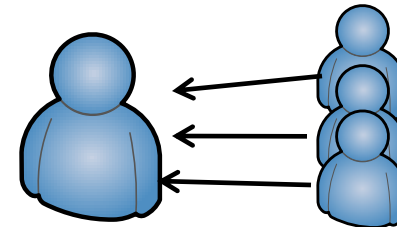
■ *Download*

- Estimate **block rarity**
- **rarest blocks first**



1

2



3

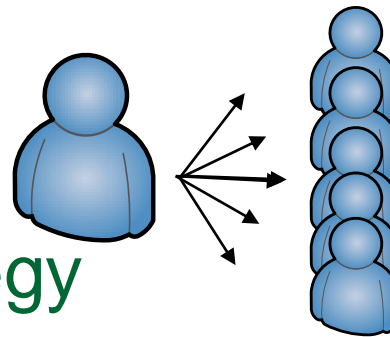
Leechers' Local Policy

■ *Download*

- ❑ Estimate block rarity
- ❑ rarest blocks first

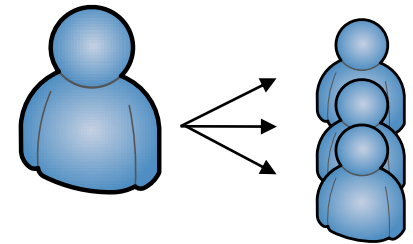
■ *Upload*

- ❑ *What*
block revelation strategy
- ❑ *To Whom*
unchoking algorithm



"I have..."

1



upload

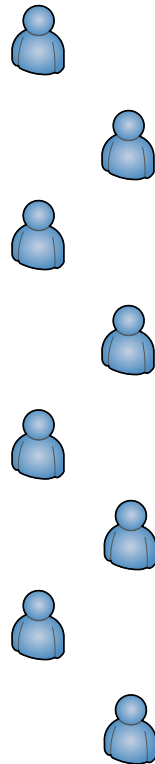
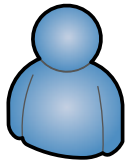
2

Outline

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-

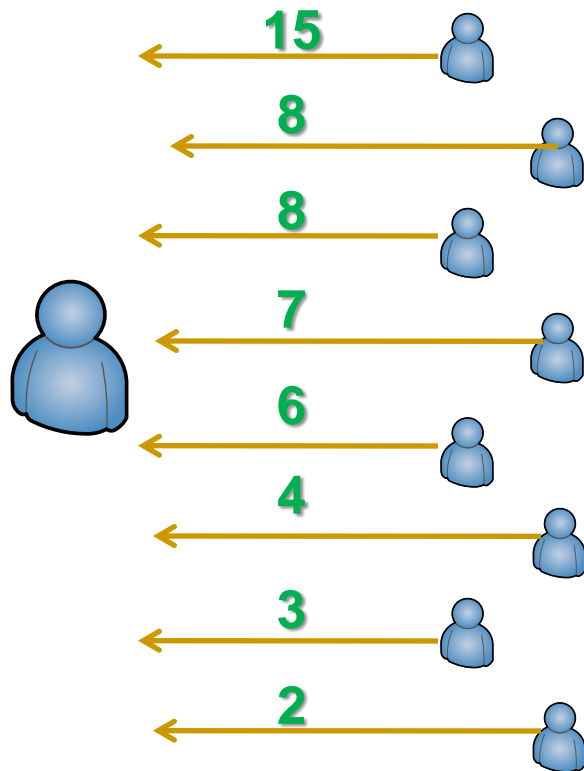
BitTorrent Auction

- Round t



BitTorrent Auction

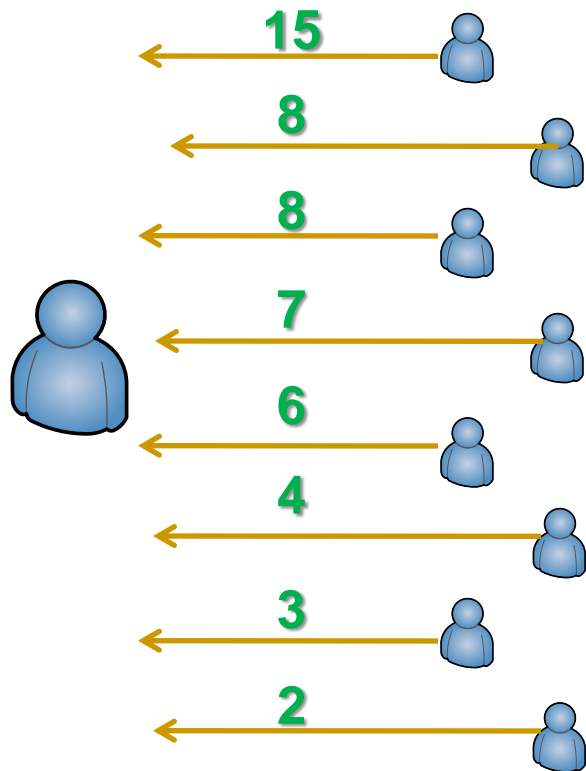
■ Round t



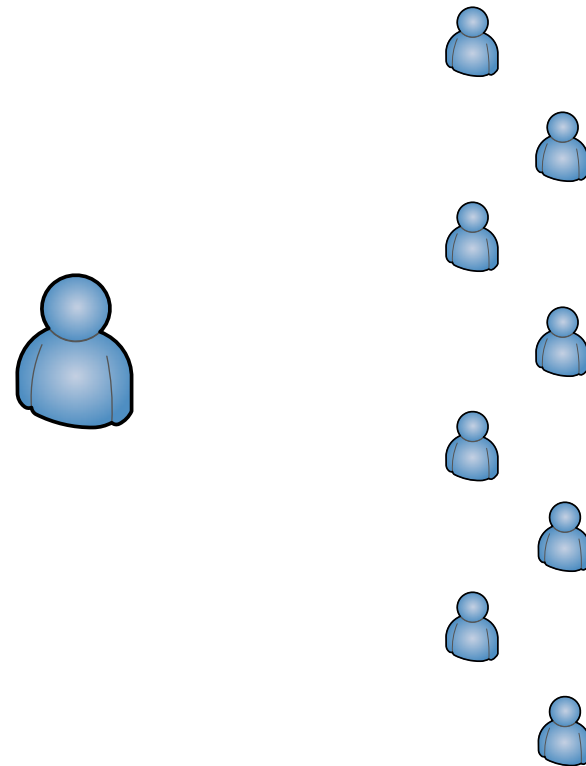
- Bids are prior round's uploads

BitTorrent Auction

■ Round t

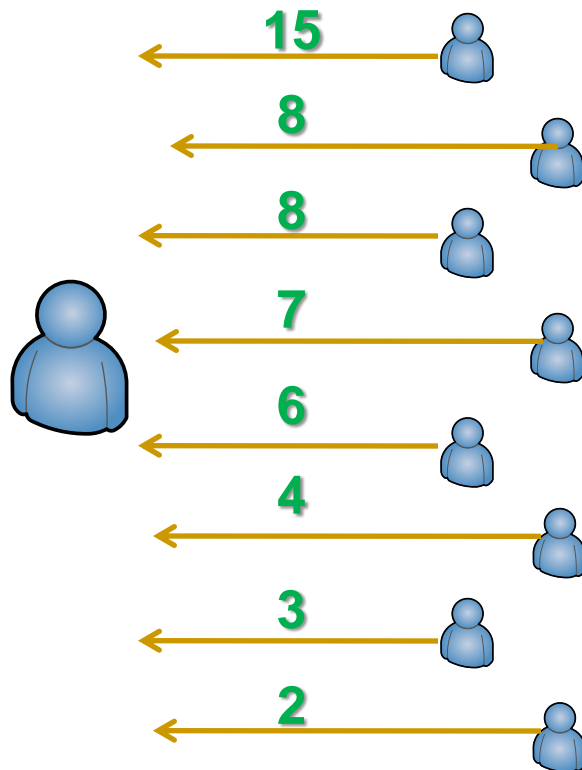


■ Round t+1

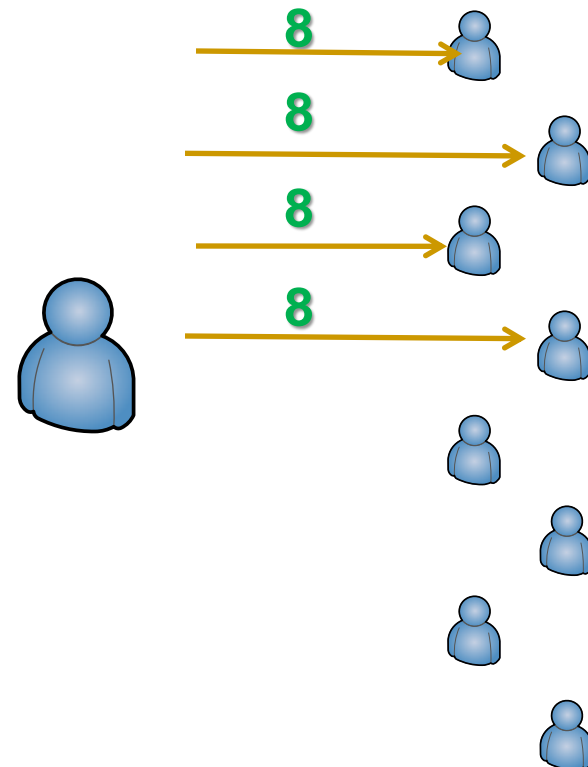


BitTorrent Auction

■ Round t



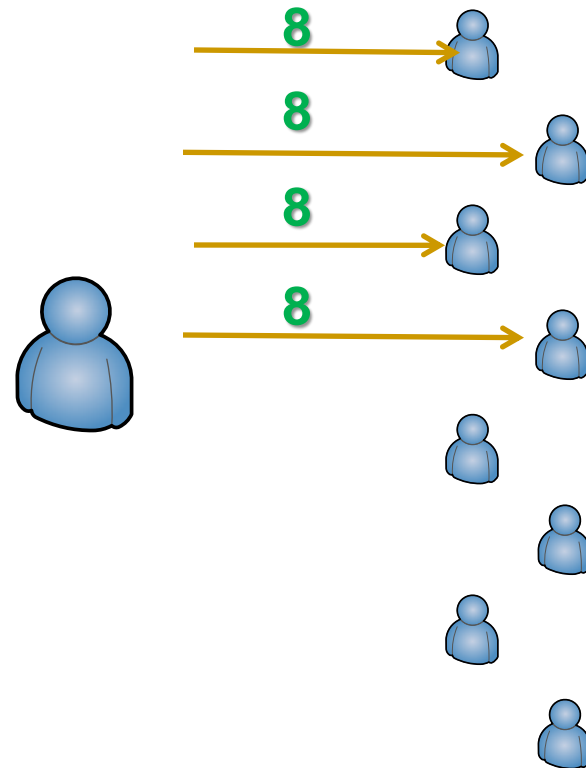
■ Round t+1



BitTorrent Auction

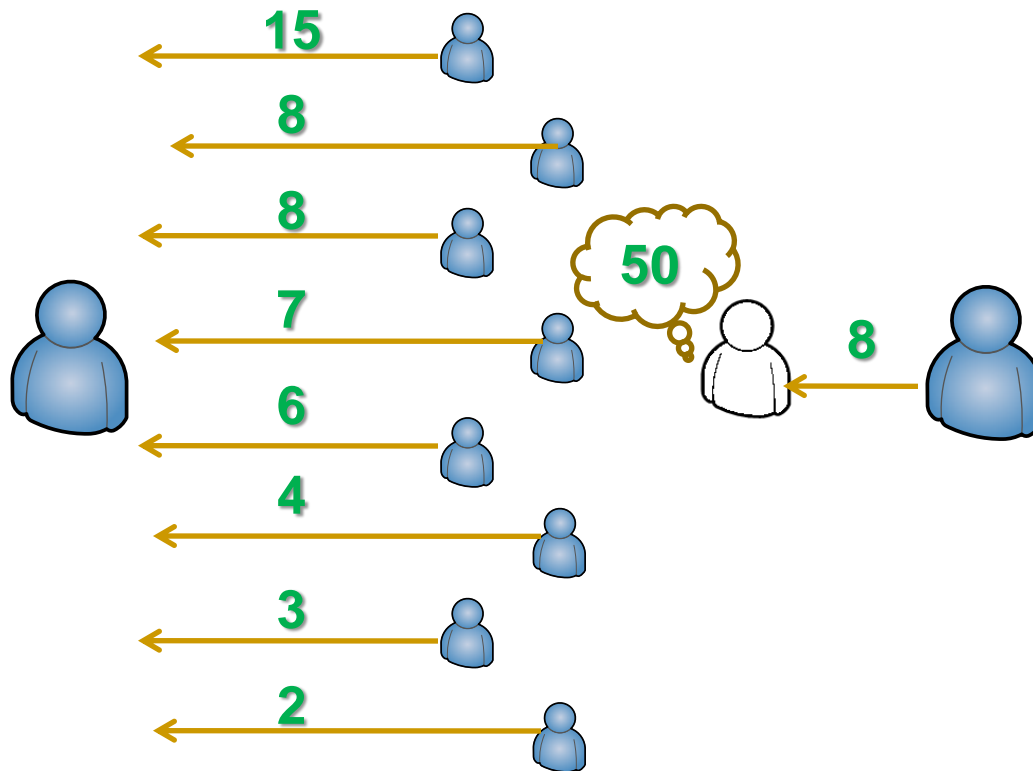
- Fixed number of equal goods
- Auction clearing is “top 4”

- Round $t+1$

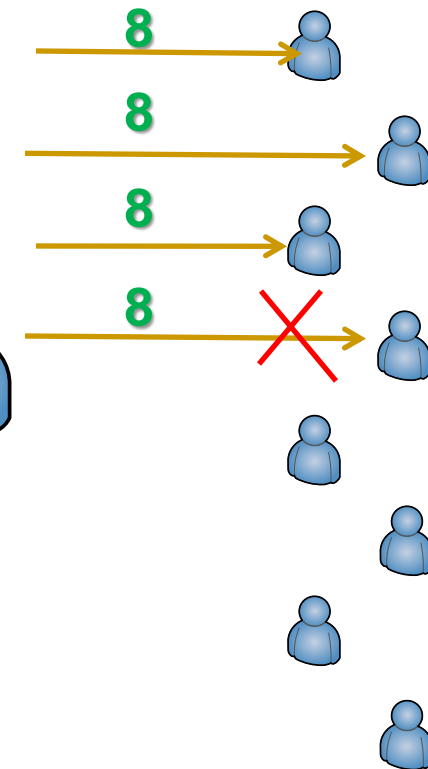


Gaming BitTorrent's Auction

■ Round t

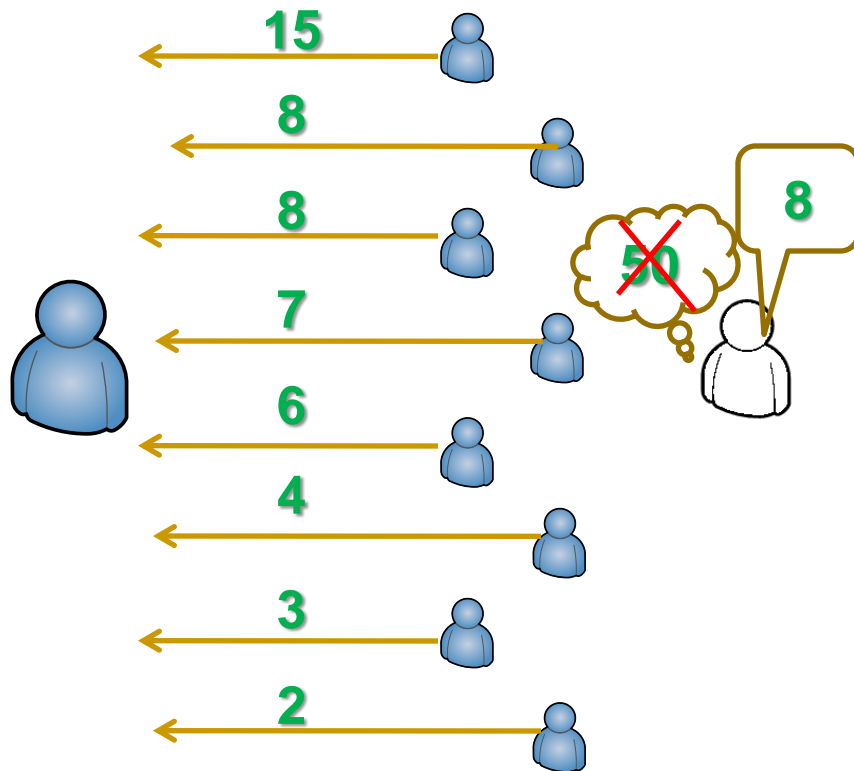


■ Round t+1

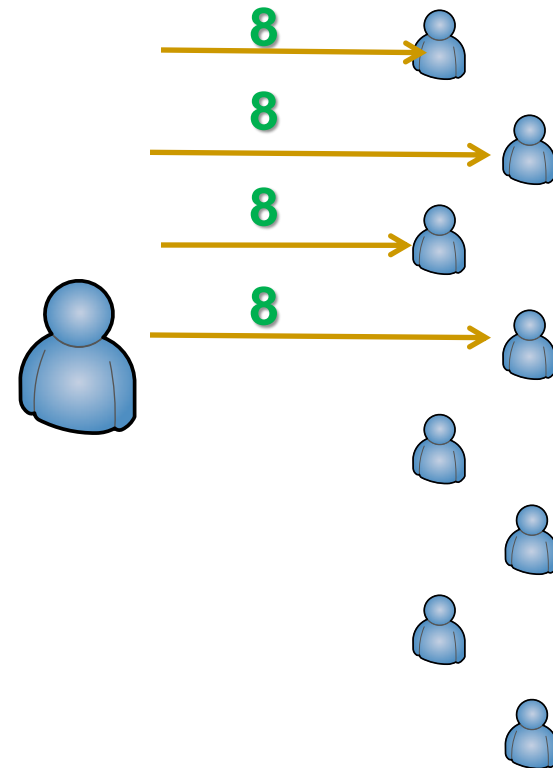


Gaming BitTorrent's Auction

■ Round t

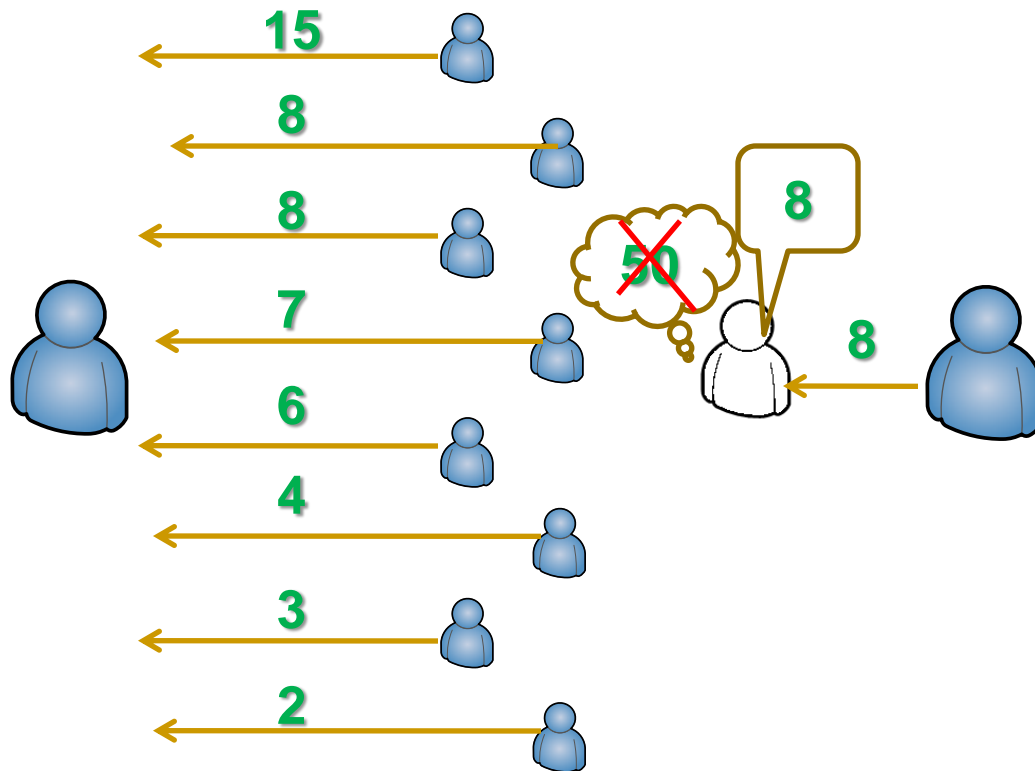


■ Round t+1

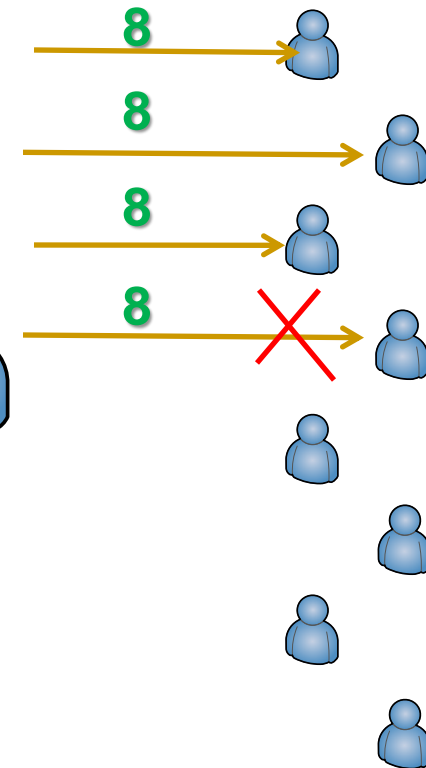


Gaming BitTorrent's Auction

■ Round t

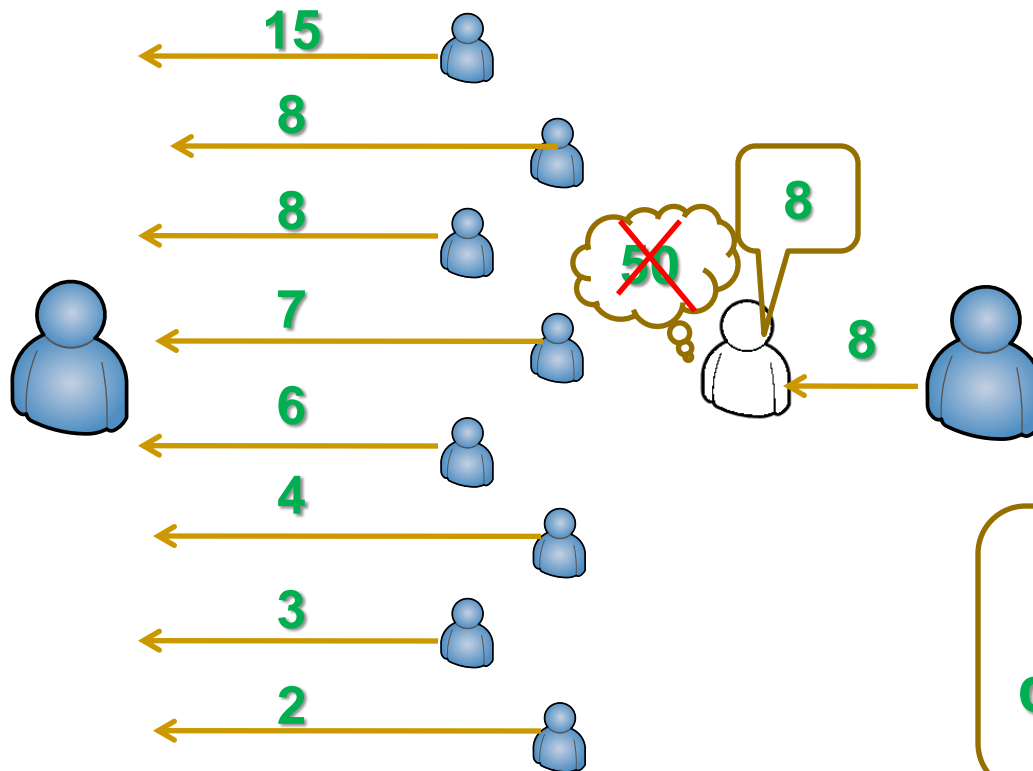


■ Round t+1

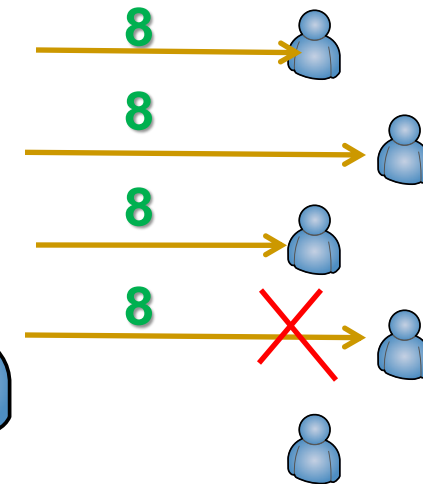


Gaming BitTorrent's Auction

■ Round t



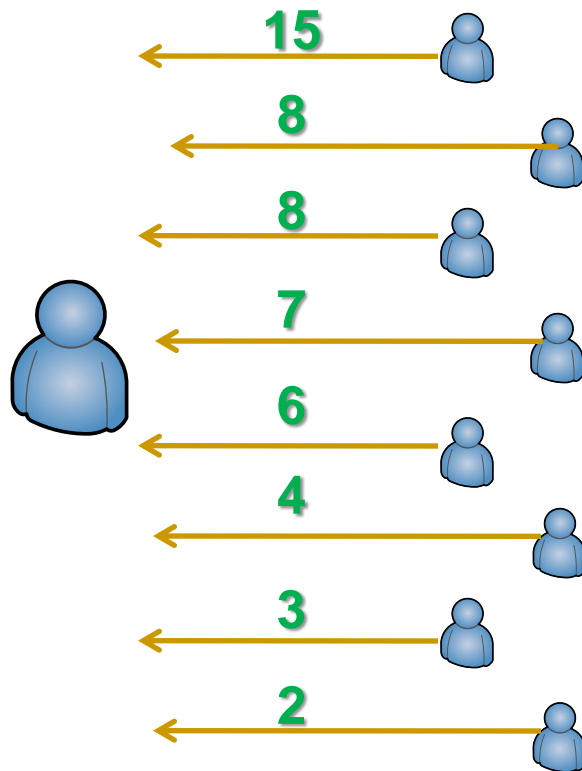
■ Round t+1



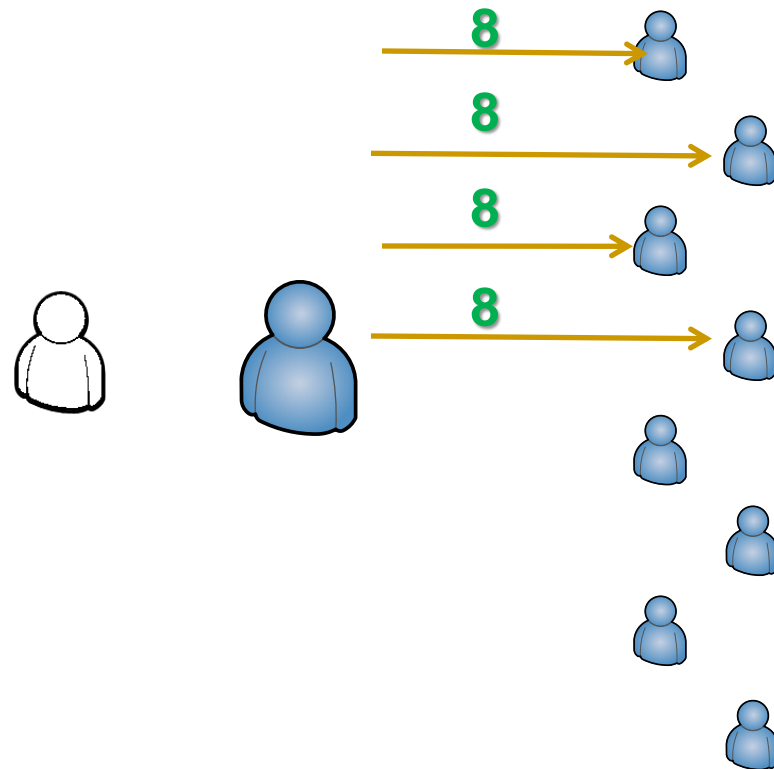
**Best to
come in last place**

Gaming BitTorrent's Auction

■ Round t

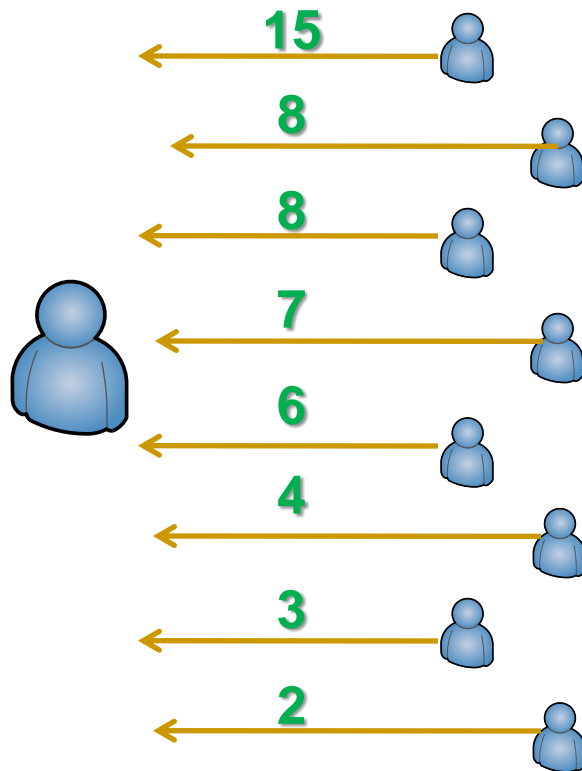


■ Round t+1

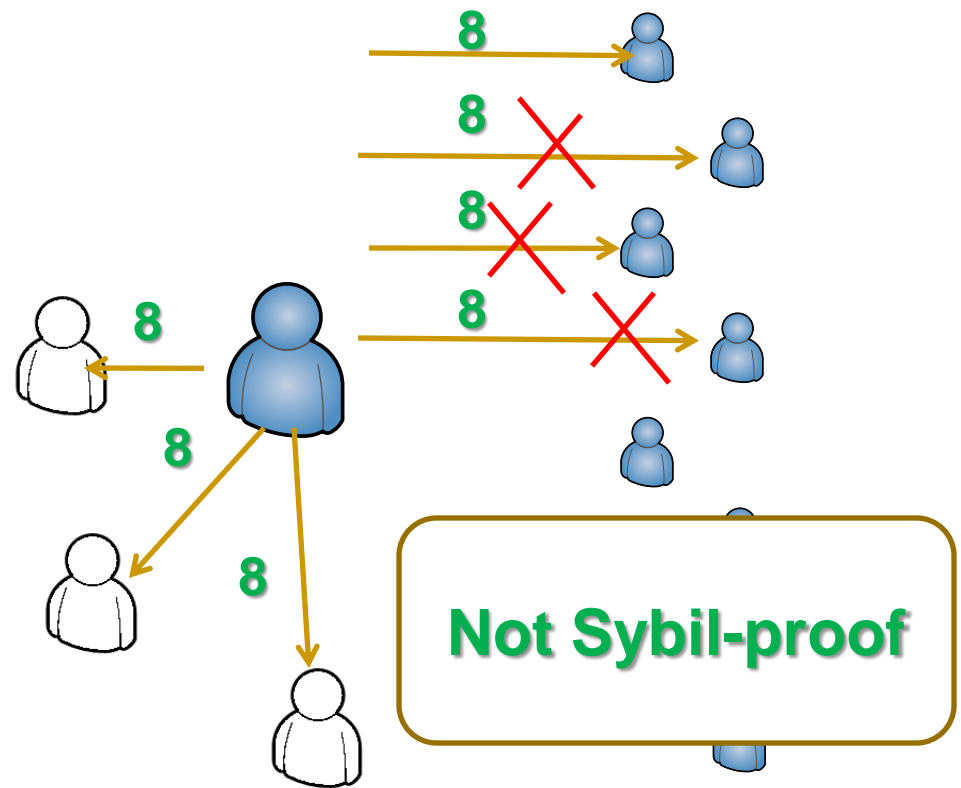


Gaming BitTorrent's Auction

■ Round t



■ Round t+1

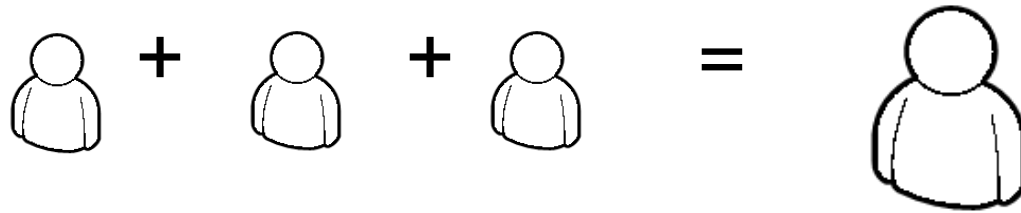


Proportional Share Auction

$$b_i^j(t) = B_i \cdot \frac{b_j^i(t-1)}{\sum_k b_k^i(t-1)}$$

- Variable number of unequal goods
- The more you give, the more you get

Proportional Share Auction

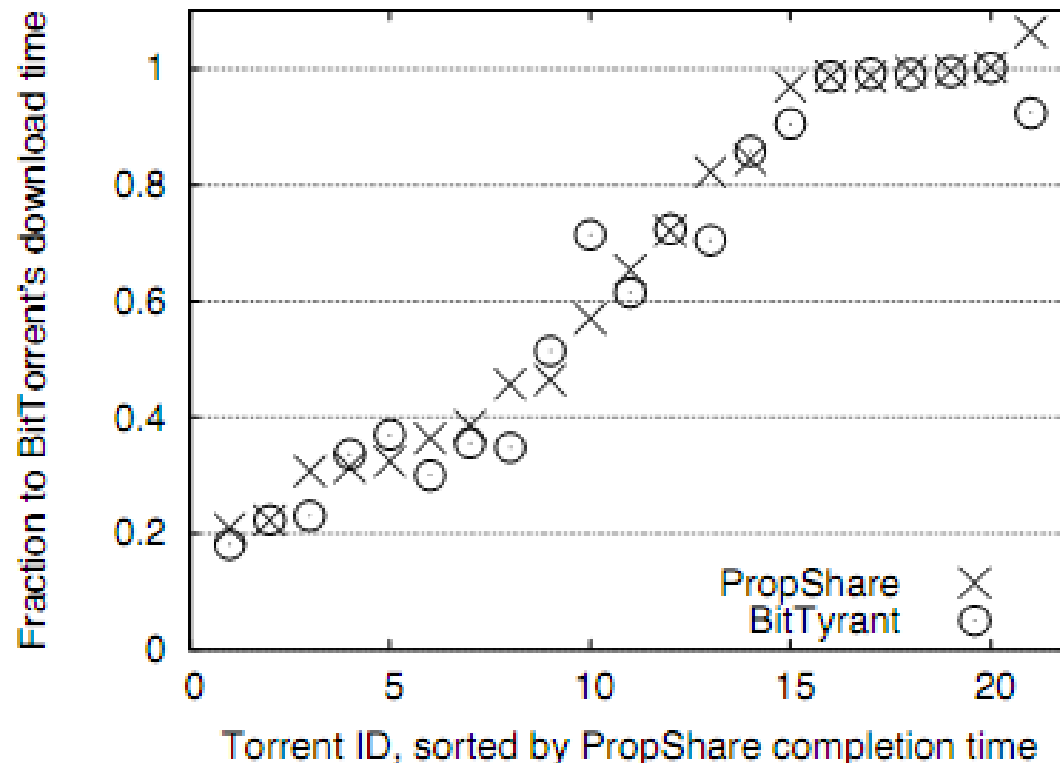


$$10/50 + 10/50 + 10/50 = 30/50$$

- PropShare is Sybil-proof

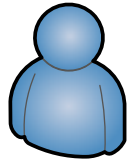
Experiments on Live Swarm

- PropShare's performance is comparable to BitTyrant

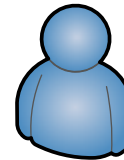


Block Revelation

0	1	1
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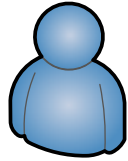


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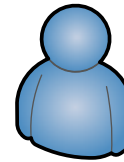
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0	1	1
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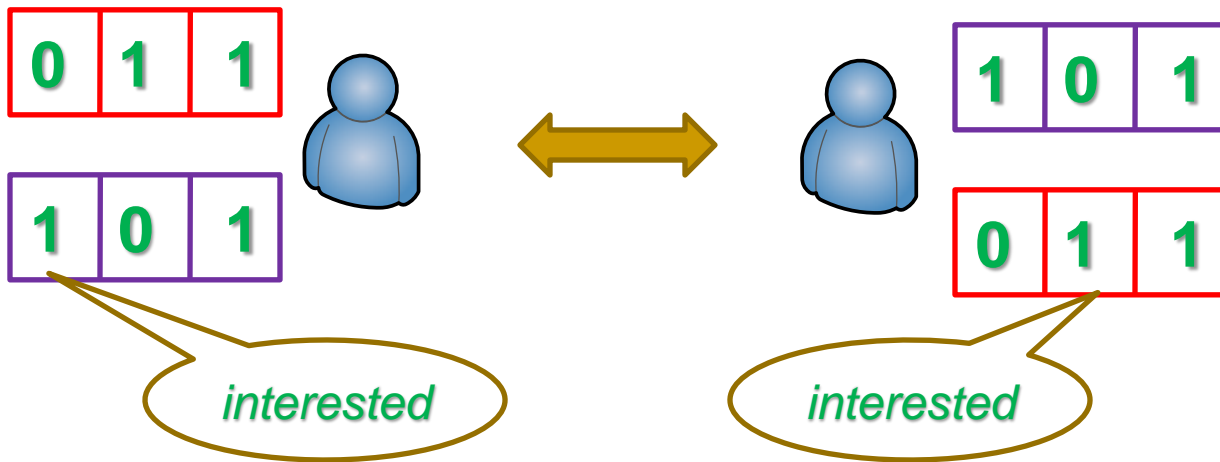
1	0	1
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1	0	1
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0	1	1
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Block Revelation



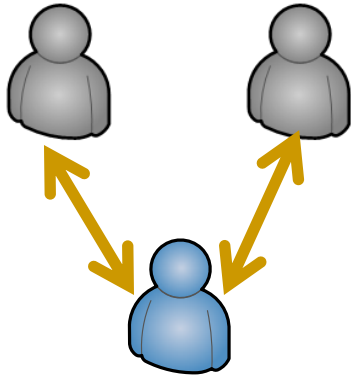
Interest



■ Most preferable

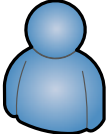
Least preferable

Interest

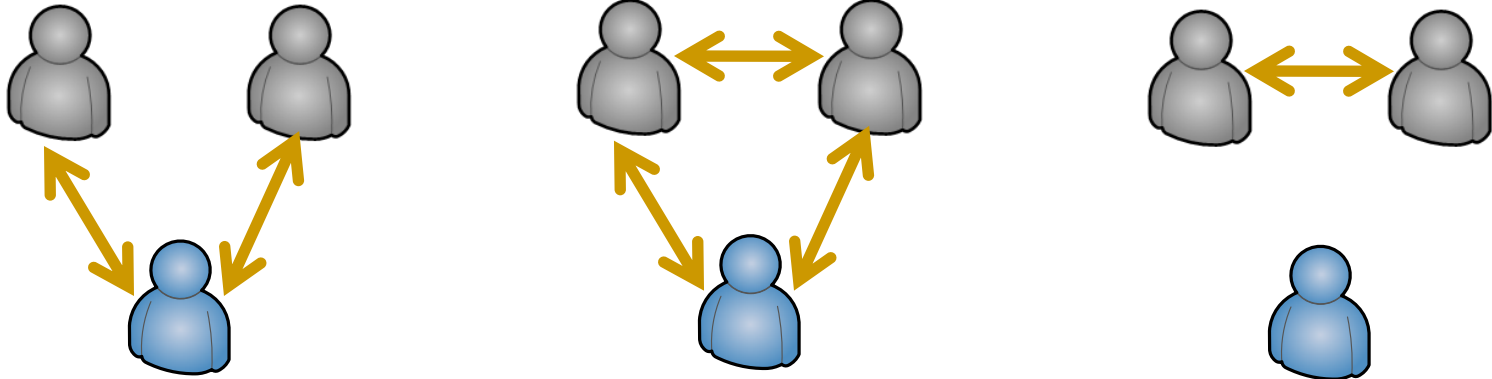


■ Most preferable

Least preferable

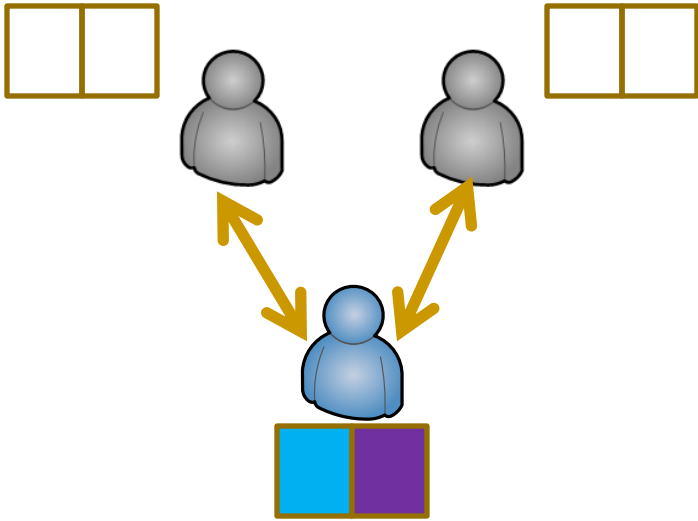
Me: 

Interest

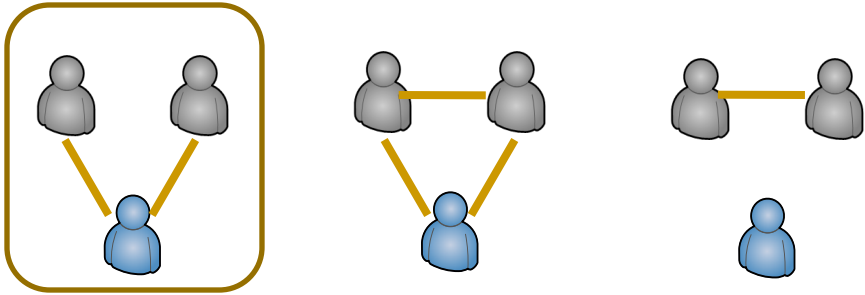
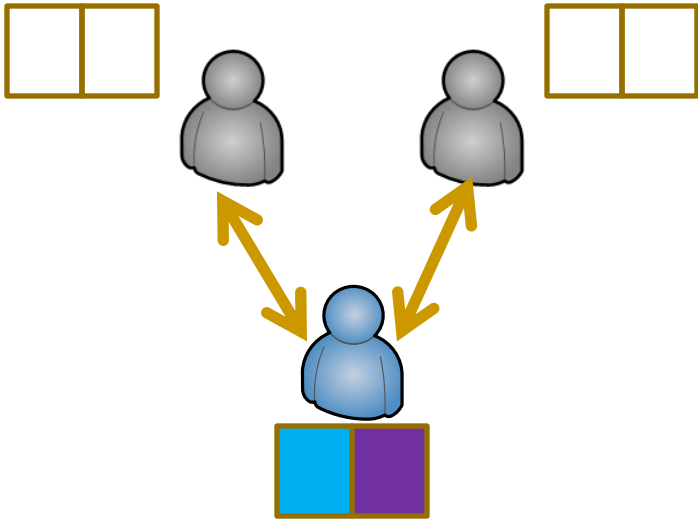


- Most preferable
- Least preferable
- Goal 1: Be interesting for as long as possible
- Goal 2: Add as little to others' interest as possible

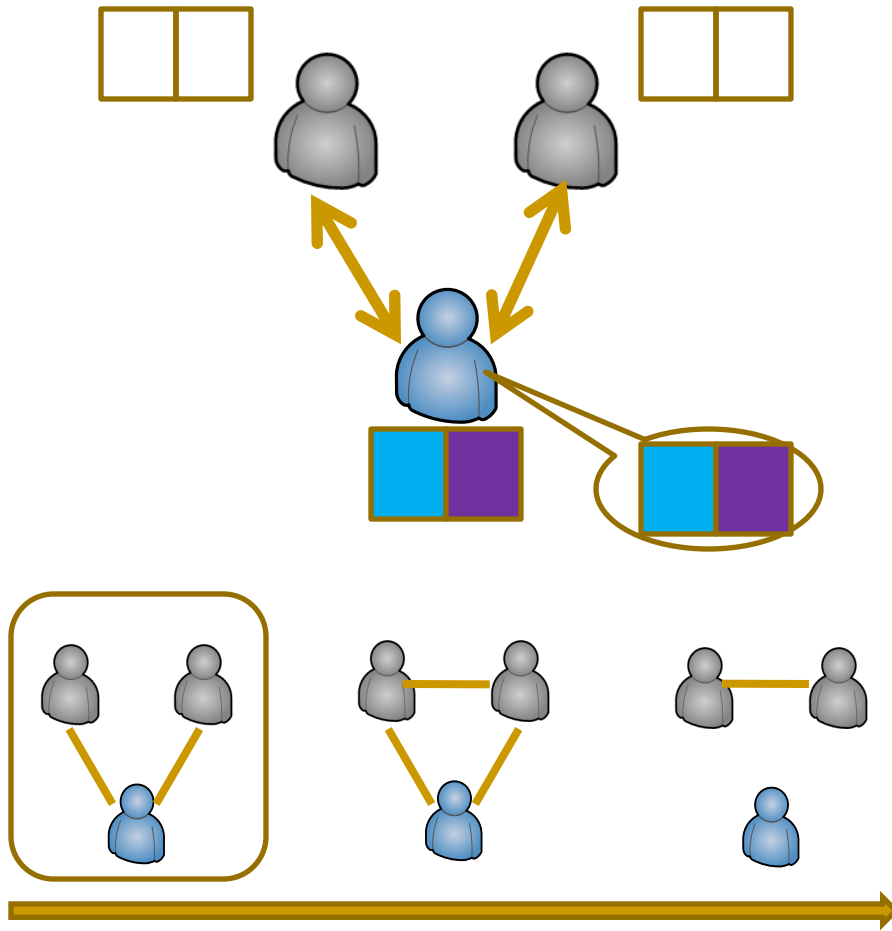
Block Revelation



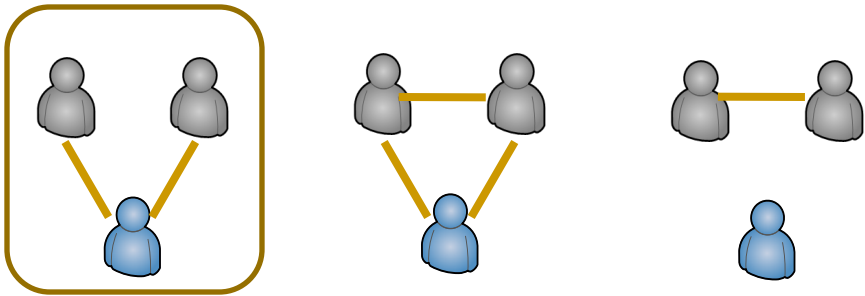
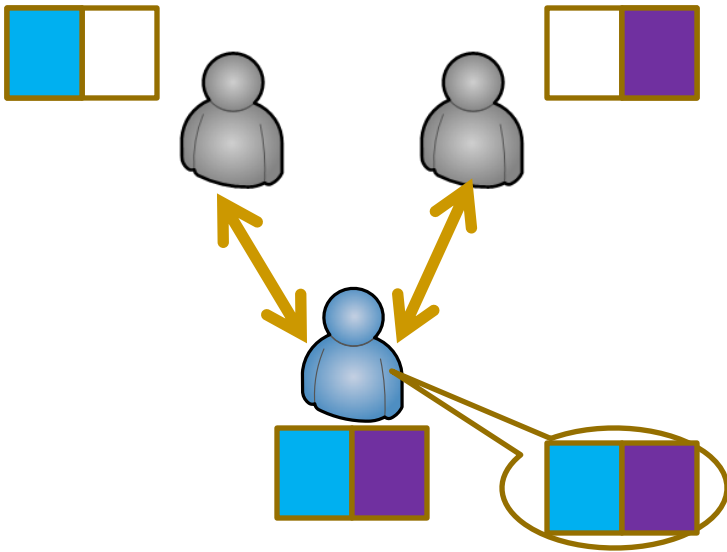
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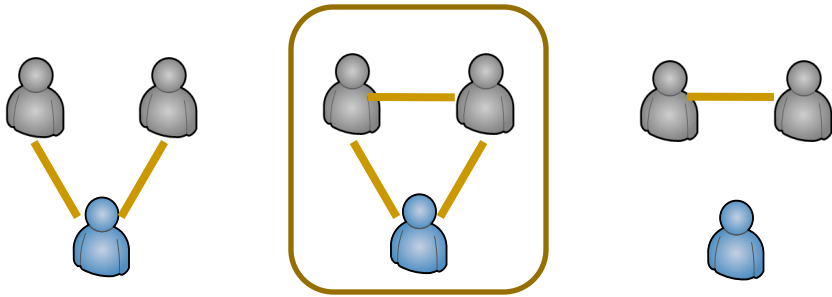
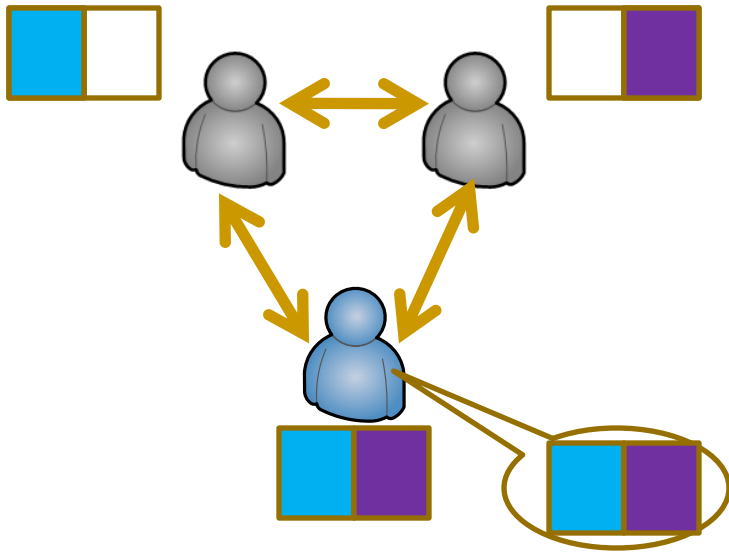
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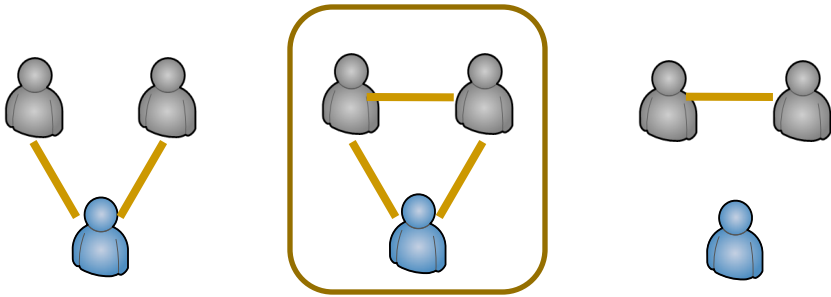
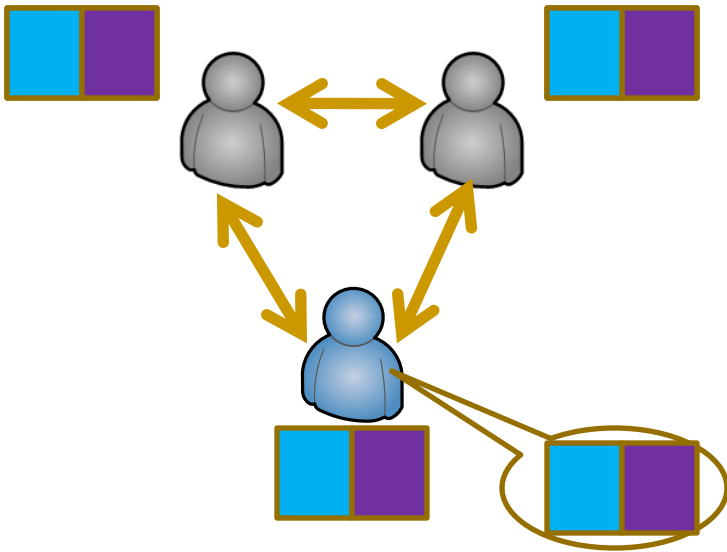
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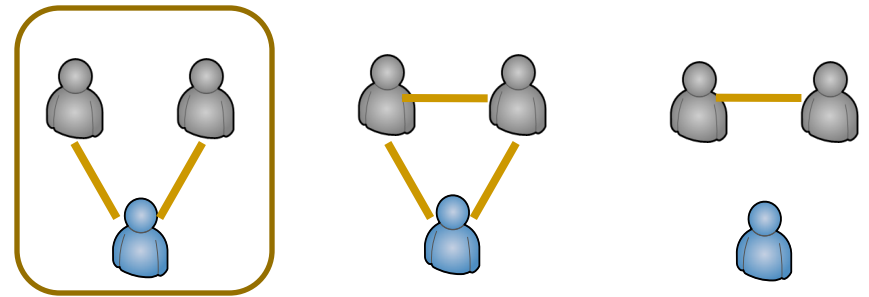
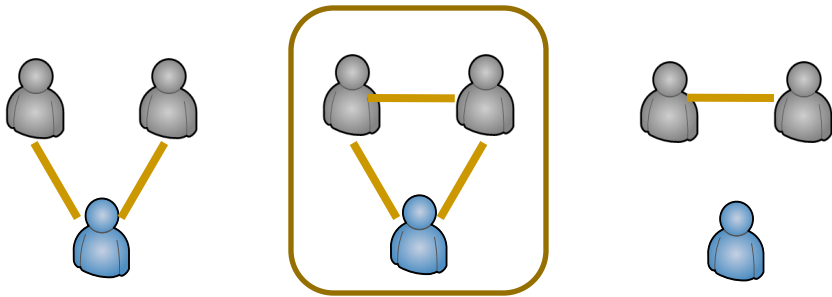
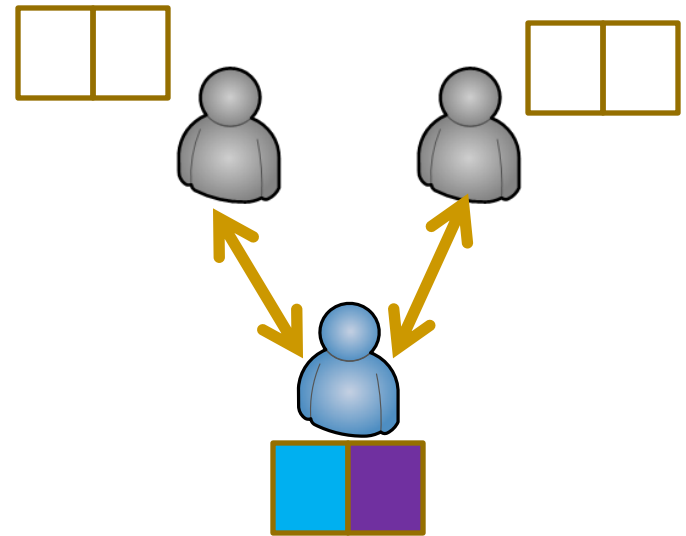
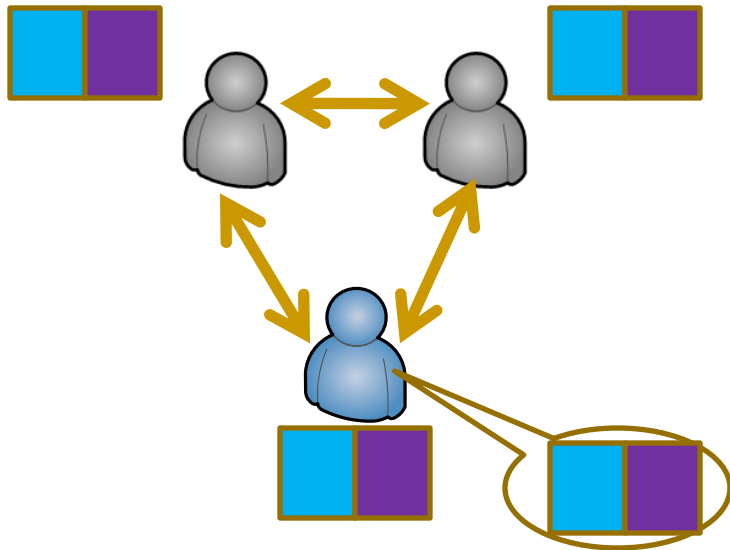
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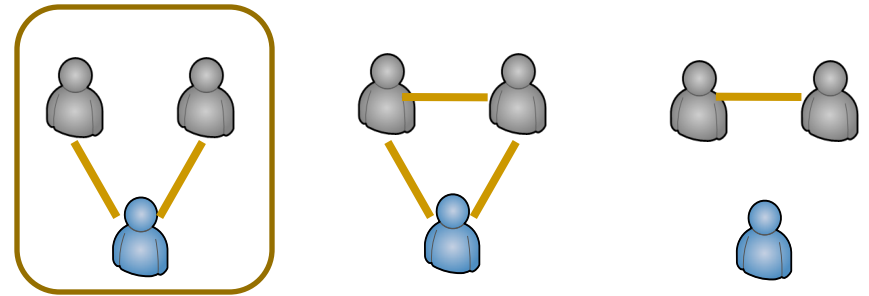
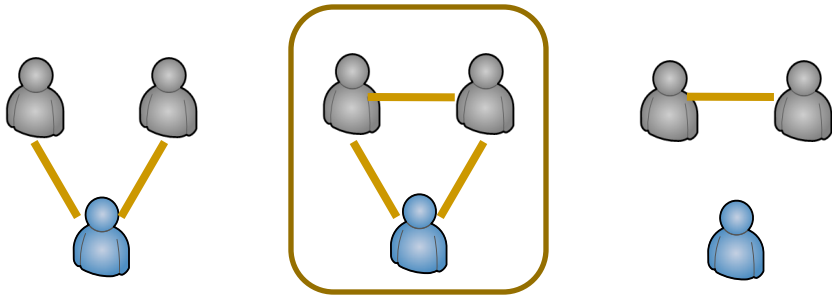
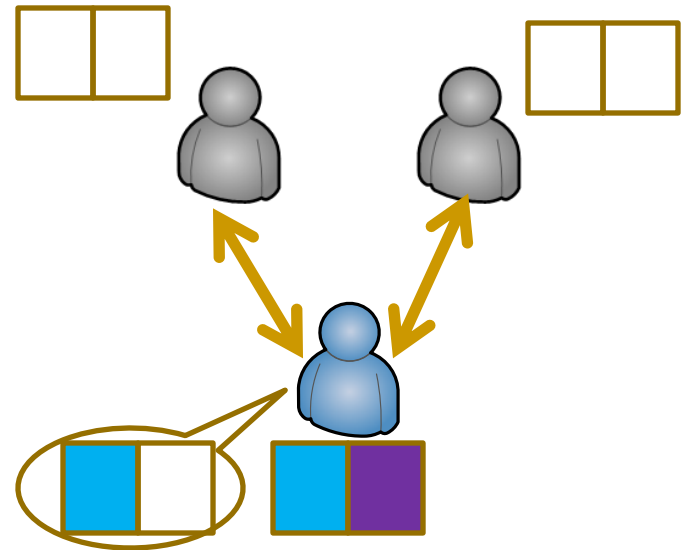
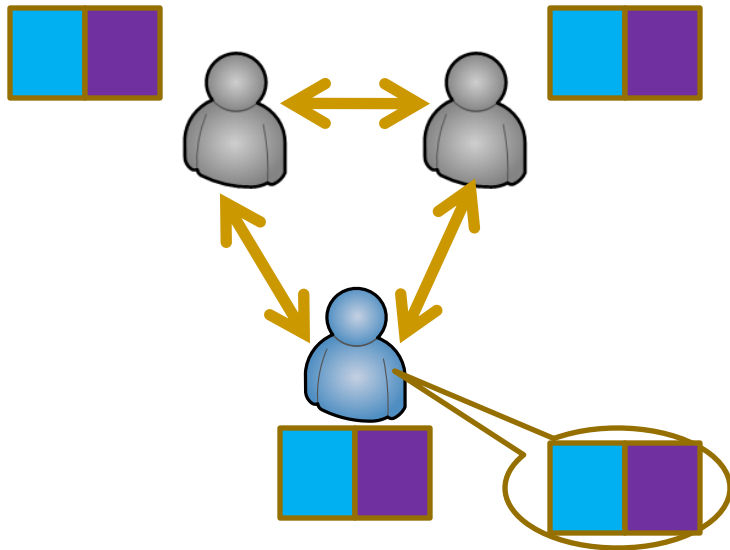
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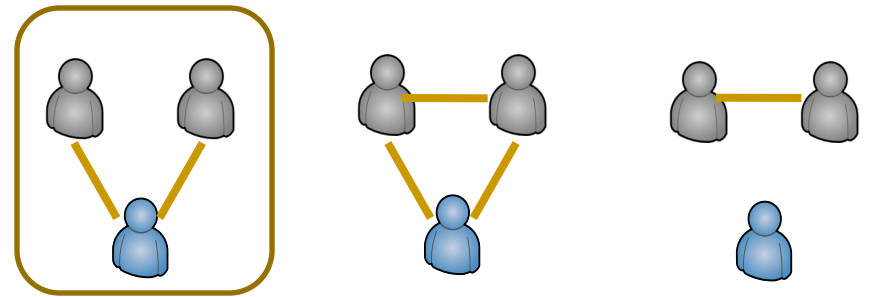
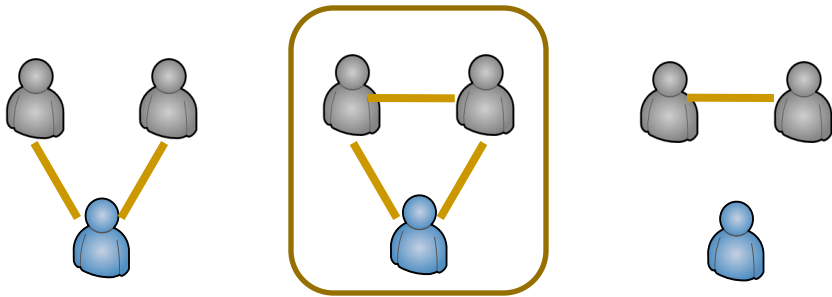
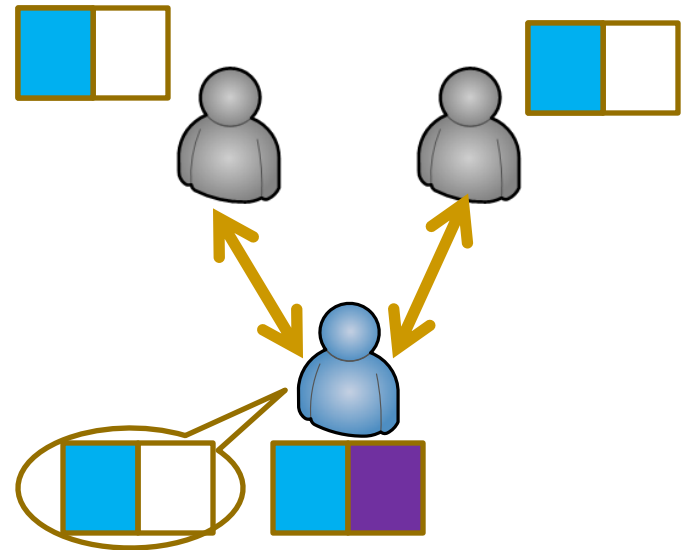
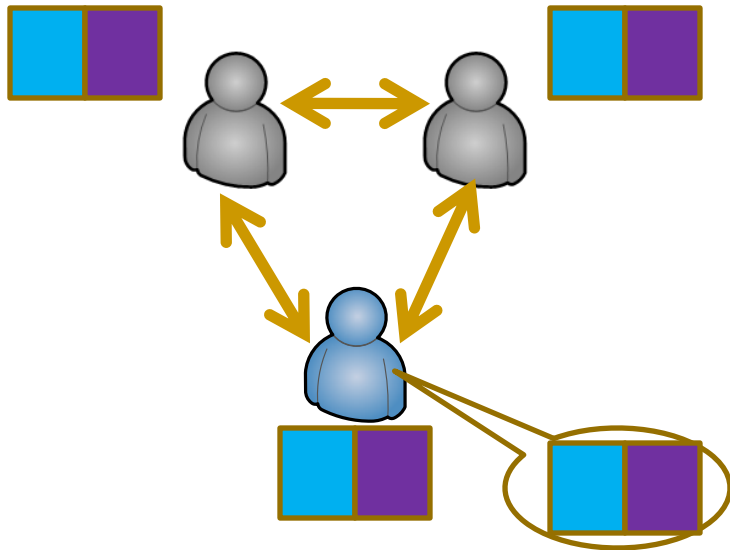
Block Revelation



Block Revelation

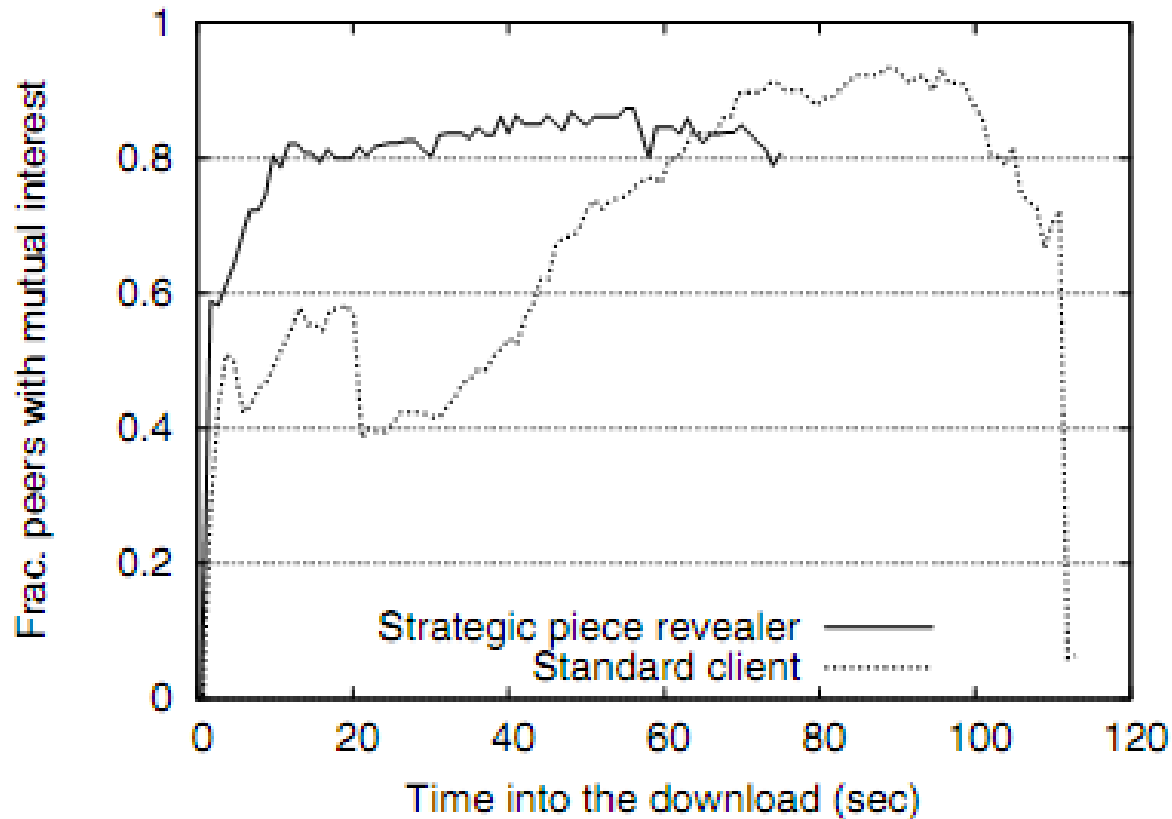


Block Revelation



Under-Reporting is Effective

One strategic revealer

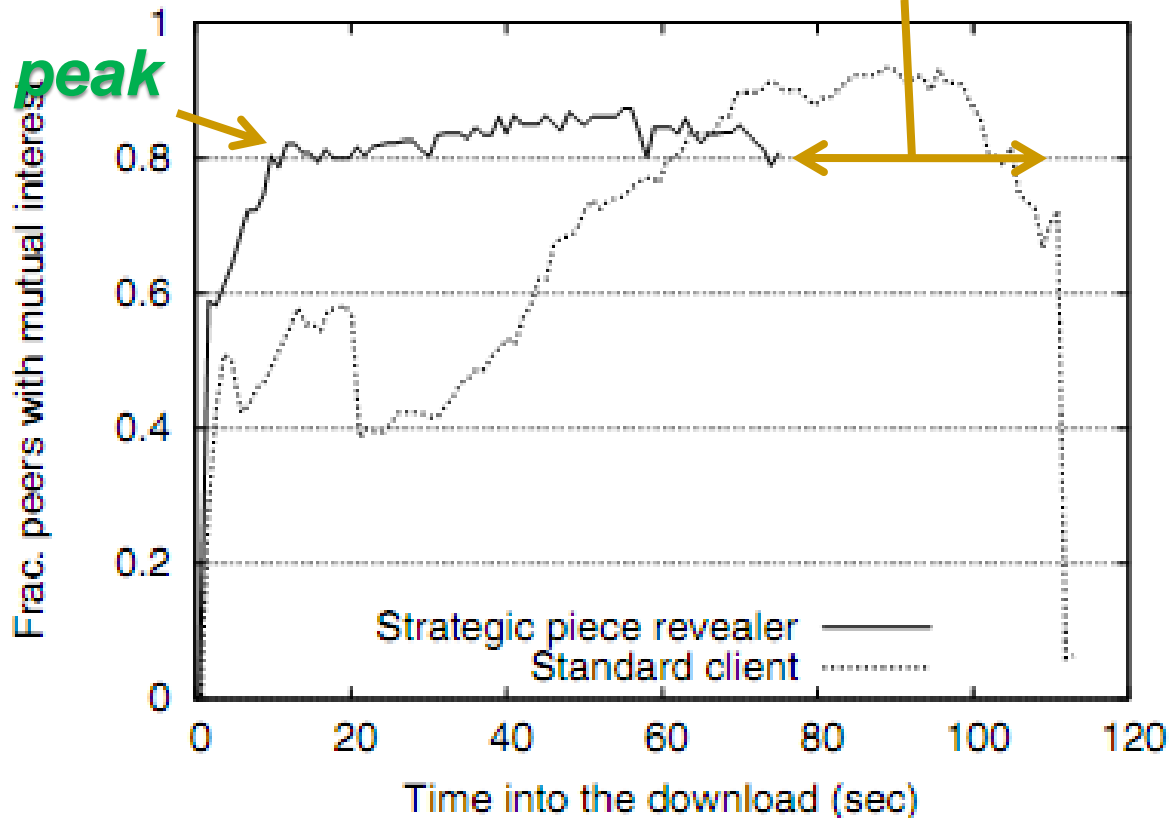


Under-Reporting is Effective

One strategic revealer

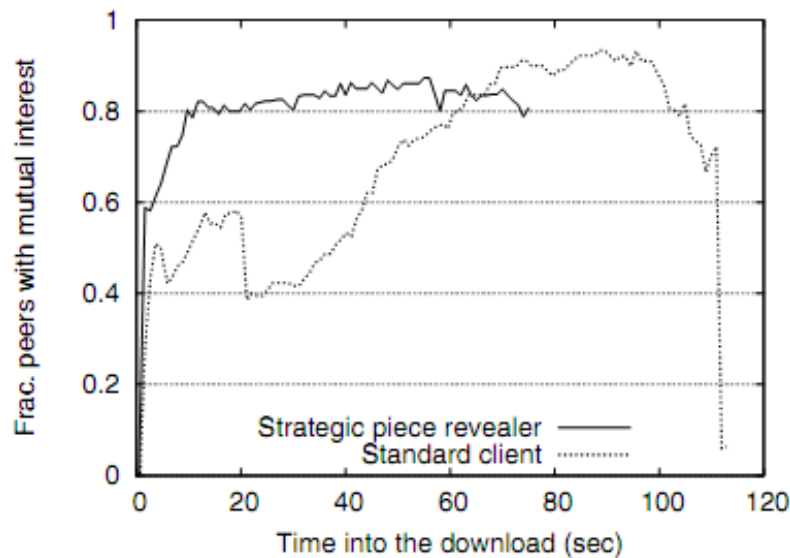
Faster Download

Reaches peak quickly



Under-Reporting is Effective

One strategic revealer



All strategic revealers

- 12% increase in download times

Summary

- BitTorrent is an auction
 - Proportional share outperforms current unchoking policy
 - More fair
 - Sybil-proof
 - Peers have incentive to under-report what they have
 - Strategic block revelation prolongs interest
-

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- “BitTorrent is an auction”
 - Model BitTorrent as an auction
 - Proportional share
 - Under-report block revelation

→ ■ Related Work

Related Work

- TrInc: Small Trusted Hardware for Large Distributed Systems
 - prTorrent : On Establishment of Piece Rarity in the BitTorrent Unchoking Algorithm
-

Thanks

