Do incentives build robustness in BitTorrent?

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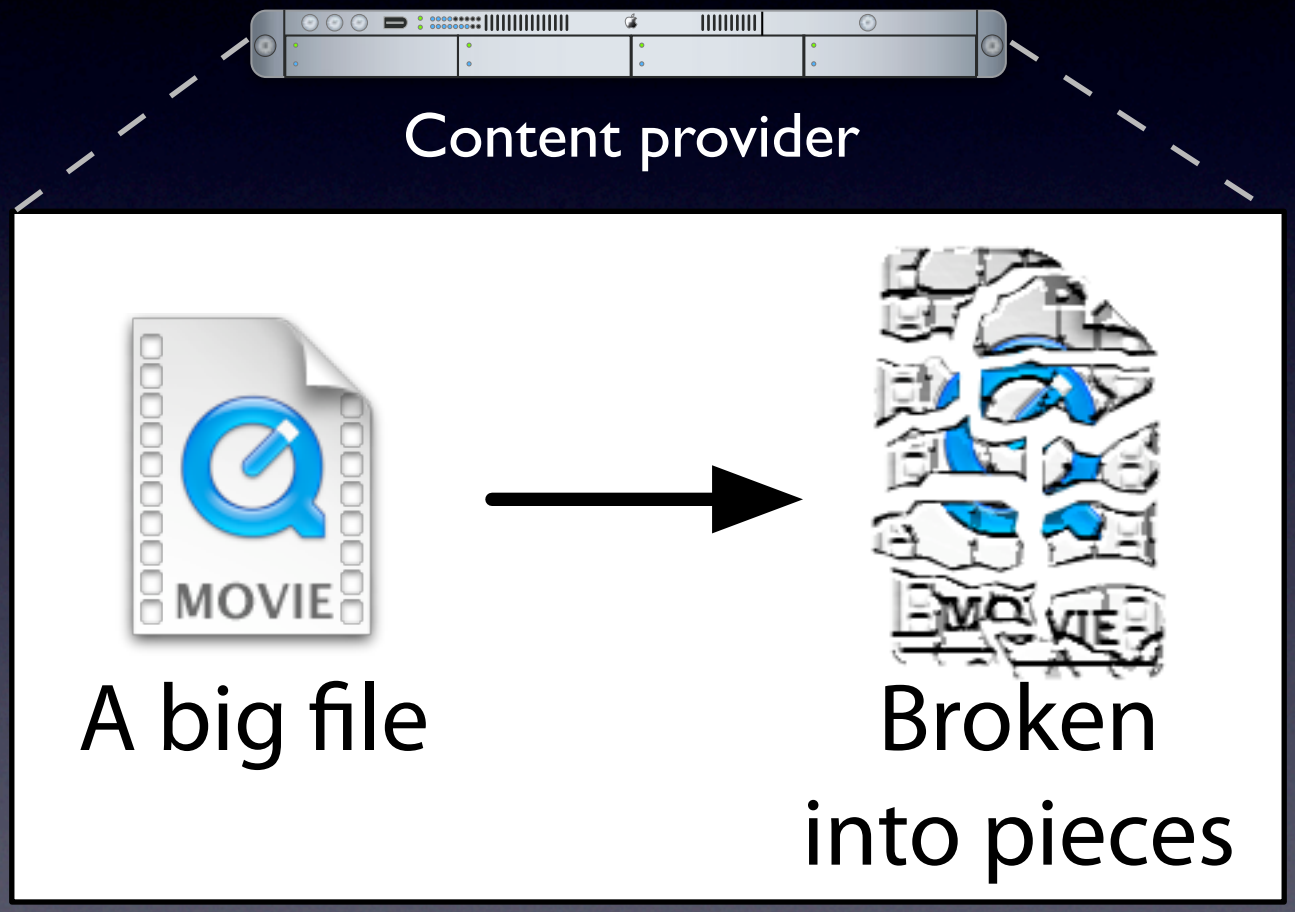
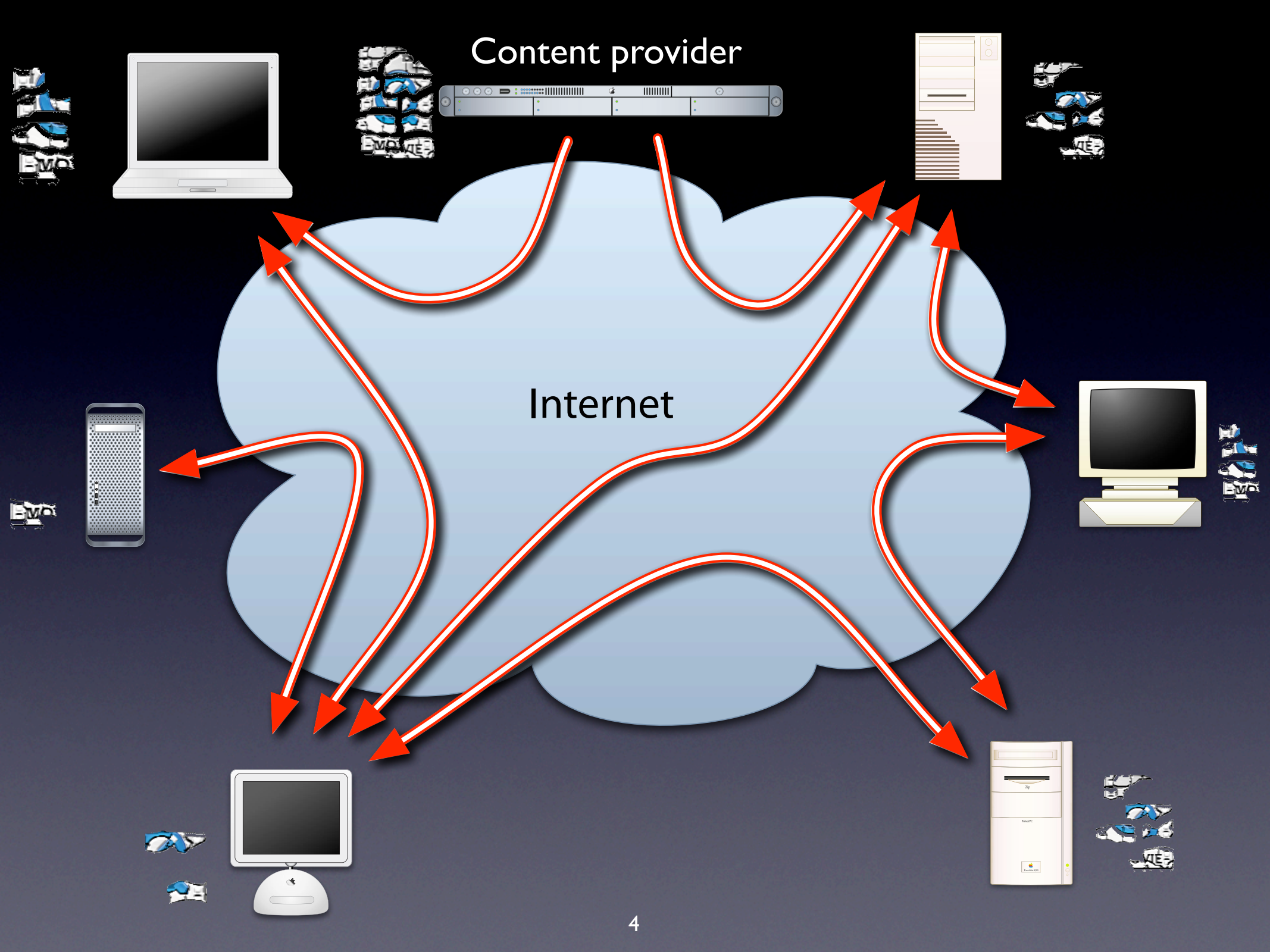
Overview

- BitTorrent: P2P file distribution tool designed with *incentives for contribution*
- Users need to contribute resources (upload capacity) to receive good performance.

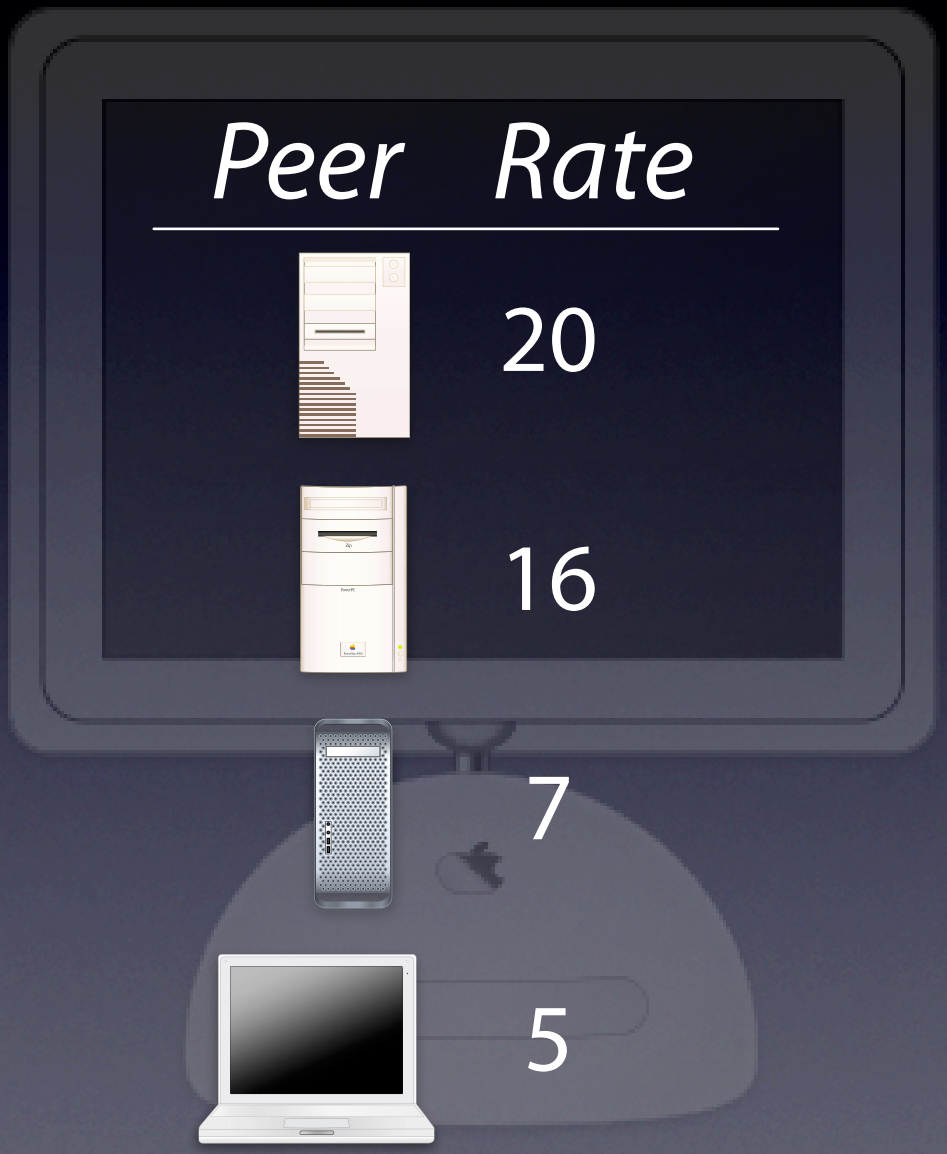
- *Main question:* Can we cheat?

How BitTorrent works




Content provider
Internet

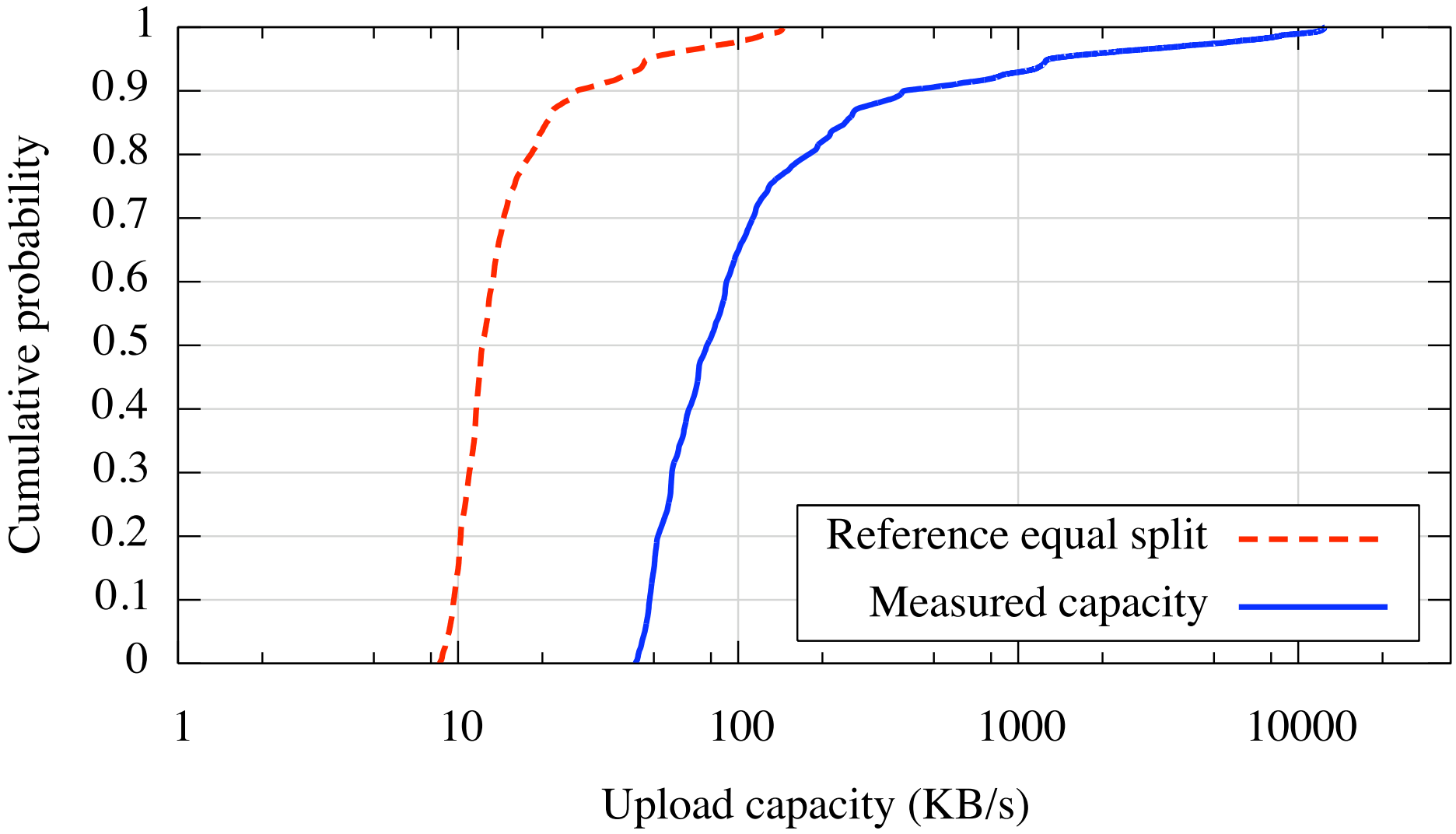
Incentives



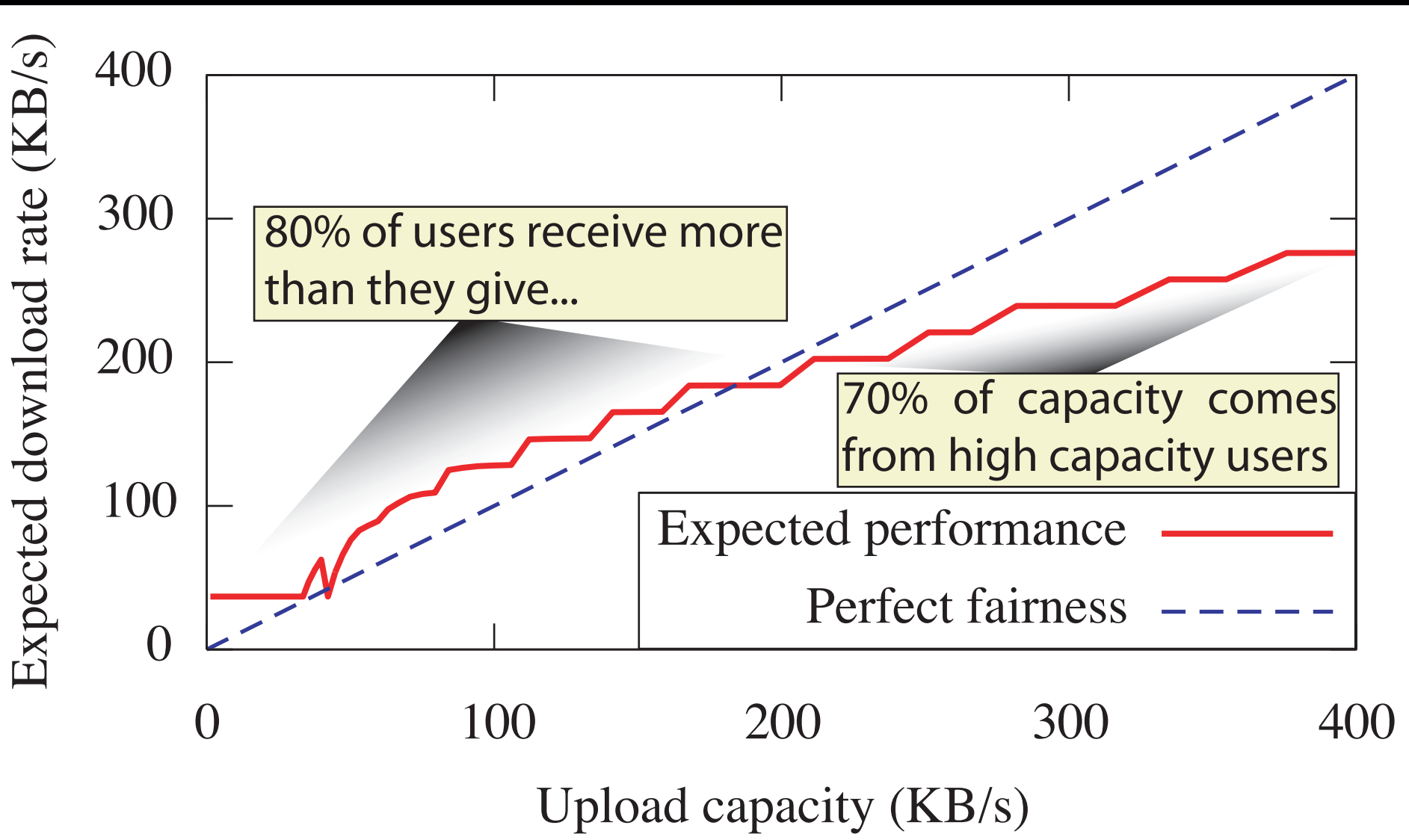
- Decisions about which peers to send data are made by each peer individually following a *tit-for-tat* policy:

- I'll send data to you if you've been sending data to me.

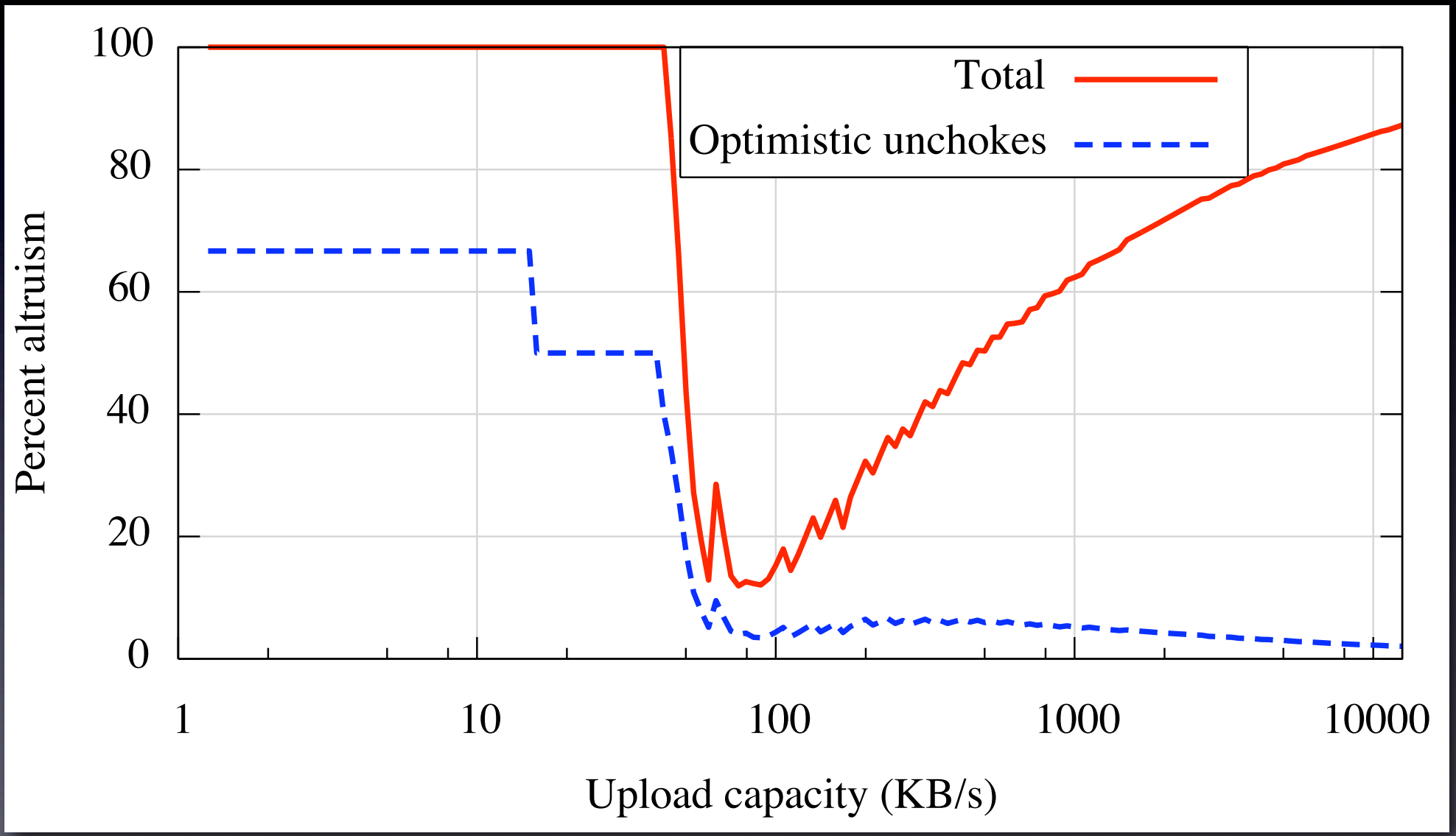
Real users


Cumulative probability
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1
10
100
1000
10000
Upload capacity (KB/s)
Reference equal split
Measured capacity

Fairness


Expected download rate (KB/s)
400
300
200
100
0
0
100
200
300
400
Upload capacity (KB/s)
80% of users receive more than they give...
70% of capacity comes from high capacity users
Expected performance
Perfect fairness

Altruism


100
80
60
40
20
0
Percent altruism
Total
Optimistic unchokes
1
10
100
1000
10000
Upload capacity (KB/s)

Building *BitTyrant*

- Can altruism in existing BitTorrent swarms be exploited by a selfish client? – Yes.

- *Key idea:* strategic selection of which peers and at what rates to send data

Core algorithm

Each round, rank order each peer p by the ratio d_p/u_p, and choose those of top rank until the local upload capacity is reached.

$$\underbrace{\frac{d_0}{u_0}, \frac{d_1}{u_1}, \frac{d_2}{u_2}, \frac{d_3}{u_3}, \frac{d_4}{u_4}}_{\text{choose } k \mid \sum_{i=0}^{k} u_i \leq \text{capacity}} \quad , \ldots$$

At the end of each round for each unchoked peer:

If peer p does not send data: increase cost estimate, u_p.

If peer p has unchoked us for the last minute:
reduce cost estimate, u_p.

Results

- BitTyrant improves average download performance by 70%.
- Regardless of capacity, using BitTyrant is in the selfish interest of every peer individually.
- When all peers behave selfishly, average performance degrades for all peers, even those with high capacity.