

# Towards an Incentive Mechanism for Peer-to-Peer Multimedia Live Streaming Systems

**Thomas Silverston<sup>1</sup>**

Olivier Fourmaux<sup>1</sup>

Jon Crowcroft<sup>2</sup>

<sup>1</sup>Université Pierre et Marie Curie Paris 06 - LIP6/CNRS

<sup>2</sup>University of Cambridge

P2P'08 - RWTH Aachen University, Germany

8-11 September 2008



Laboratoire d'Informatique de Paris 6

# Motivation

- P2P to provide large scale content distribution in the Internet
  - Ex. BitTorrent for file sharing
- New class of P2P Application: P2P live streaming
  - Ex. P2P IPTV
- P2P IPTV architecture inspired by BitTorrent
  - PPLive, PPStream, SOPCast, UUSee etc.
- BitTorrent architecture relies on its incentive mechanism [B. Cohen Incentive Build Robustness in BitTorrent, P2P ECON 2003]
  - Collaboration/fairness between peers (tit-for-tat policy)

# Motivation

- P2P Live streaming
  - Multimedia flows
    - Continuous nature of the transmission
  - Temporal constraints
  - Different from files distribution
- The nature of the live streaming content obsoletes the incentive mechanism of BitTorrent
- New incentive Mechanism adapted to P2P IPTV

# Outline

- 1. Motivation
- 2. Architecture of BitTorrent
  - Review of BitTorrent Functionality
  - Limitations of BitTorrent's Incentive mechanism
- 3. Measurement of Real Systems
- 4. A novel incentive mechanism for P2P IPTV
- 5. Conclusion and future work

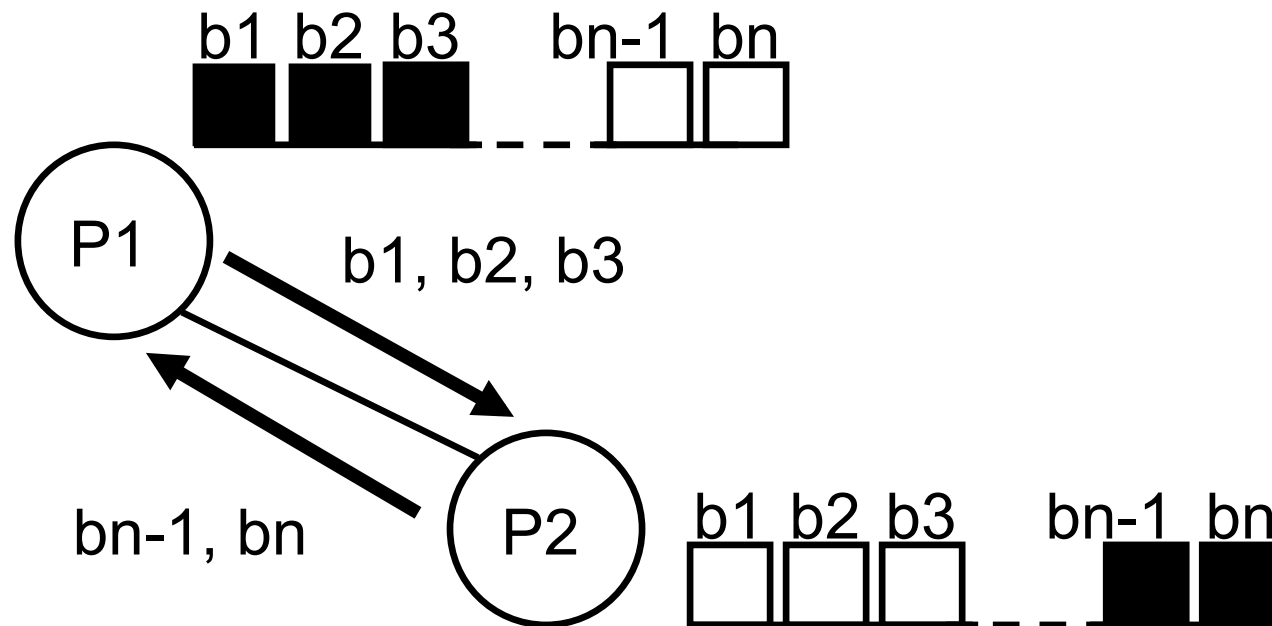
# Architecture of BitTorrent

- A File is divided into a collection of blocks
  - Recover all the blocks to download the file
- Peers exchange buffer map and download blocks from different peers
- Peers are organized into a transient Mesh
  - Links depend on the peers interest in available blocks
- Fairness between peers
  - Incentive mechanism

# BitTorrent incentive Mechanism

- Reciprocal exchange of blocks between peers
  - Tit-for-tat policy
- Peer transmits data to another peer if the either transmits blocks in return
- Peers are encouraged to contribute
  - They are repaid by receiving new blocks
- For a File, all the blocks must be downloaded before the file can be used
  - All the blocks have equal importance
  - Download all the blocks in no particular order (beginning, middle or end of file)

# Example of exchange with BitTorrent



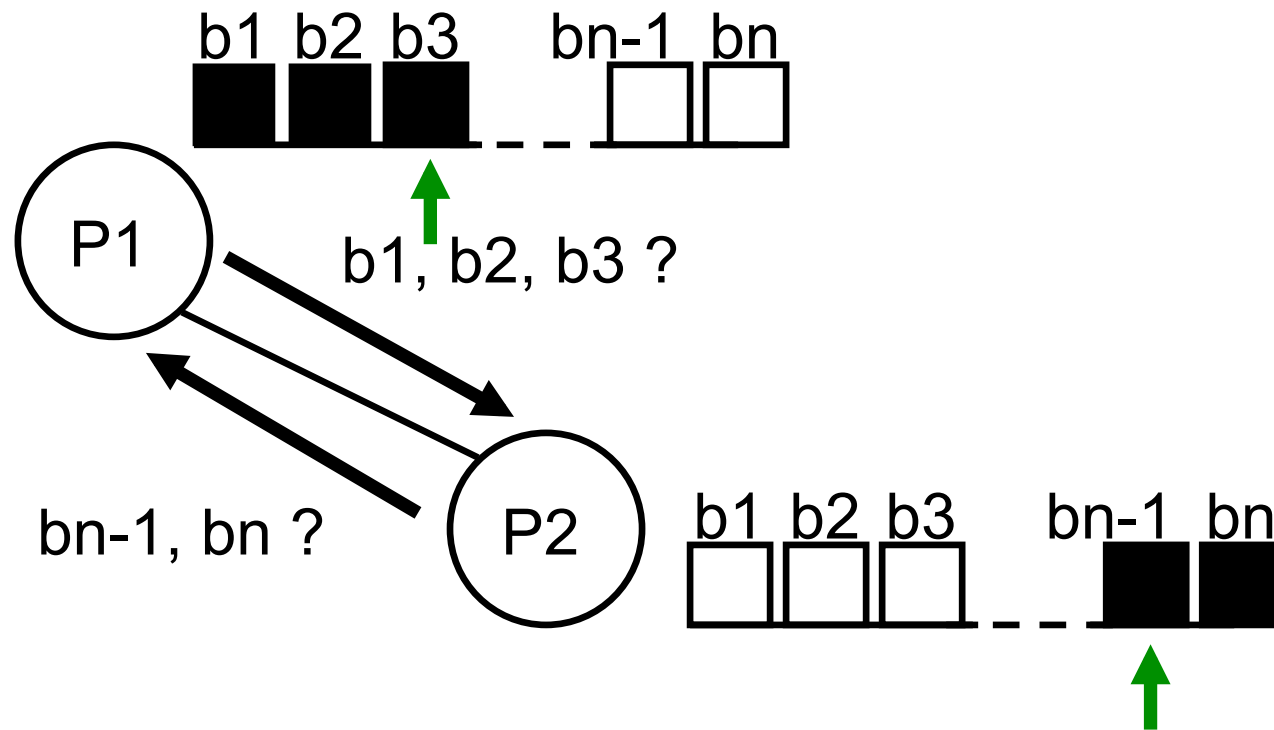
■ available block

□ missing block

# Limitations of BitTorrent's Incentive Mechanism

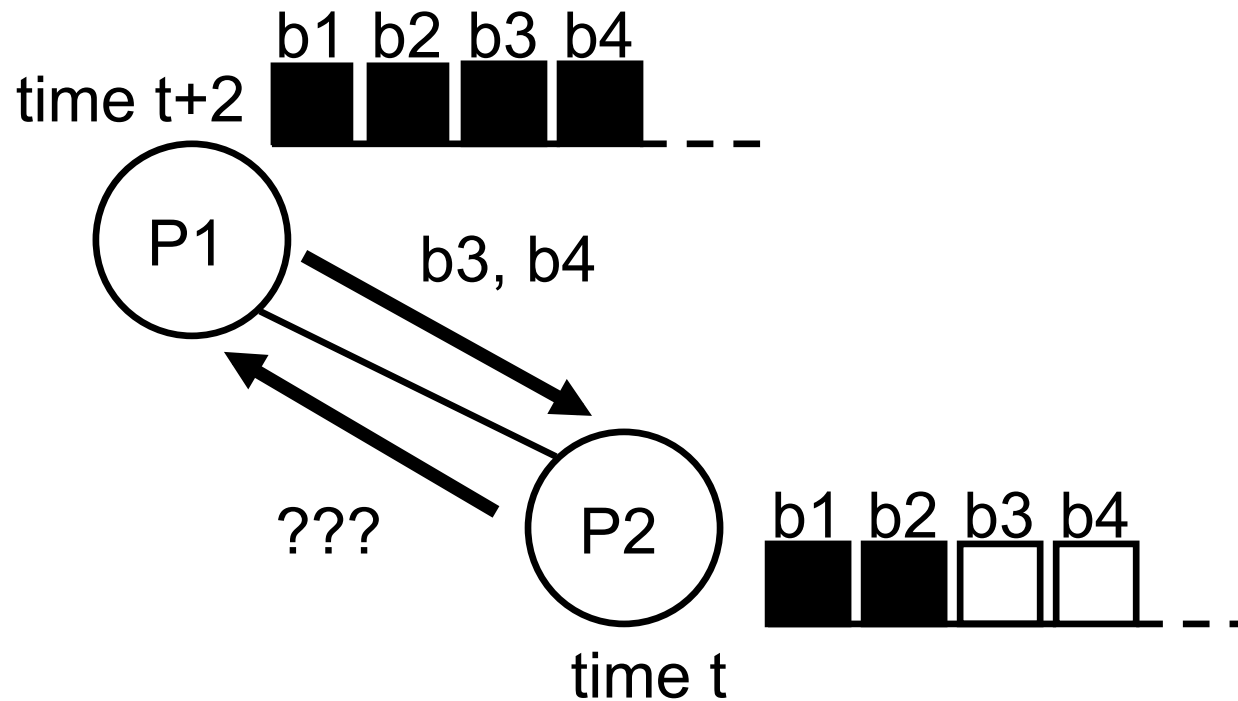
- Live multimedia flows (Ex. TV)
  - Consumed on-the-fly as they are received
- Blocks do not have the same importance given their position in the flow
  - Blocks have to be consumed in real time
- Temporal constraints for multimedia flows
  - Continuous nature of the transmission
  - Different from files distribution
- Block  $b$  must be consumed before block  $b+1$ 
  - Respect playback time

# Example of exchange with BitTorrent and a live multimedia flow



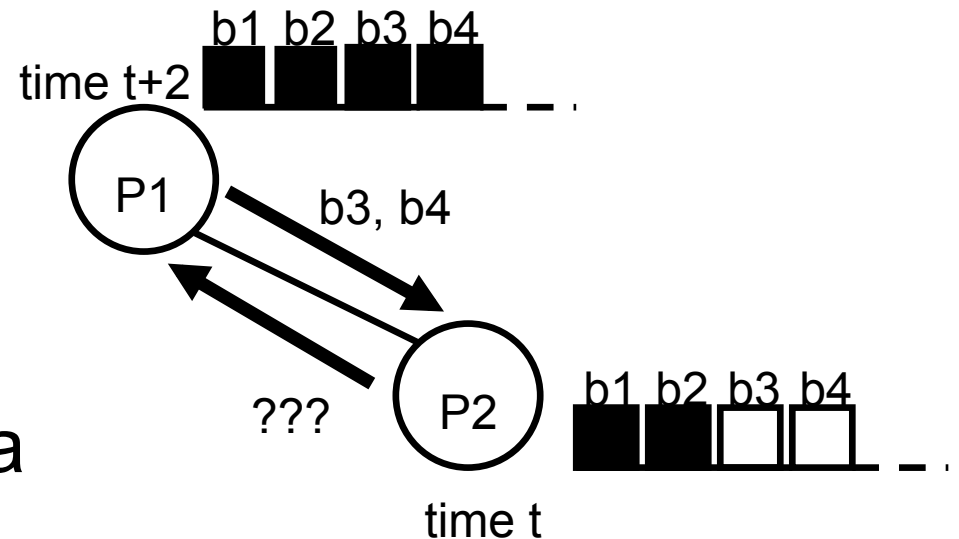
P1 and P2 are at different point  in the playout

# Example of exchange with BitTorrent and a live multimedia flow



# Limitations of BitTorrent's Incentive Mechanism

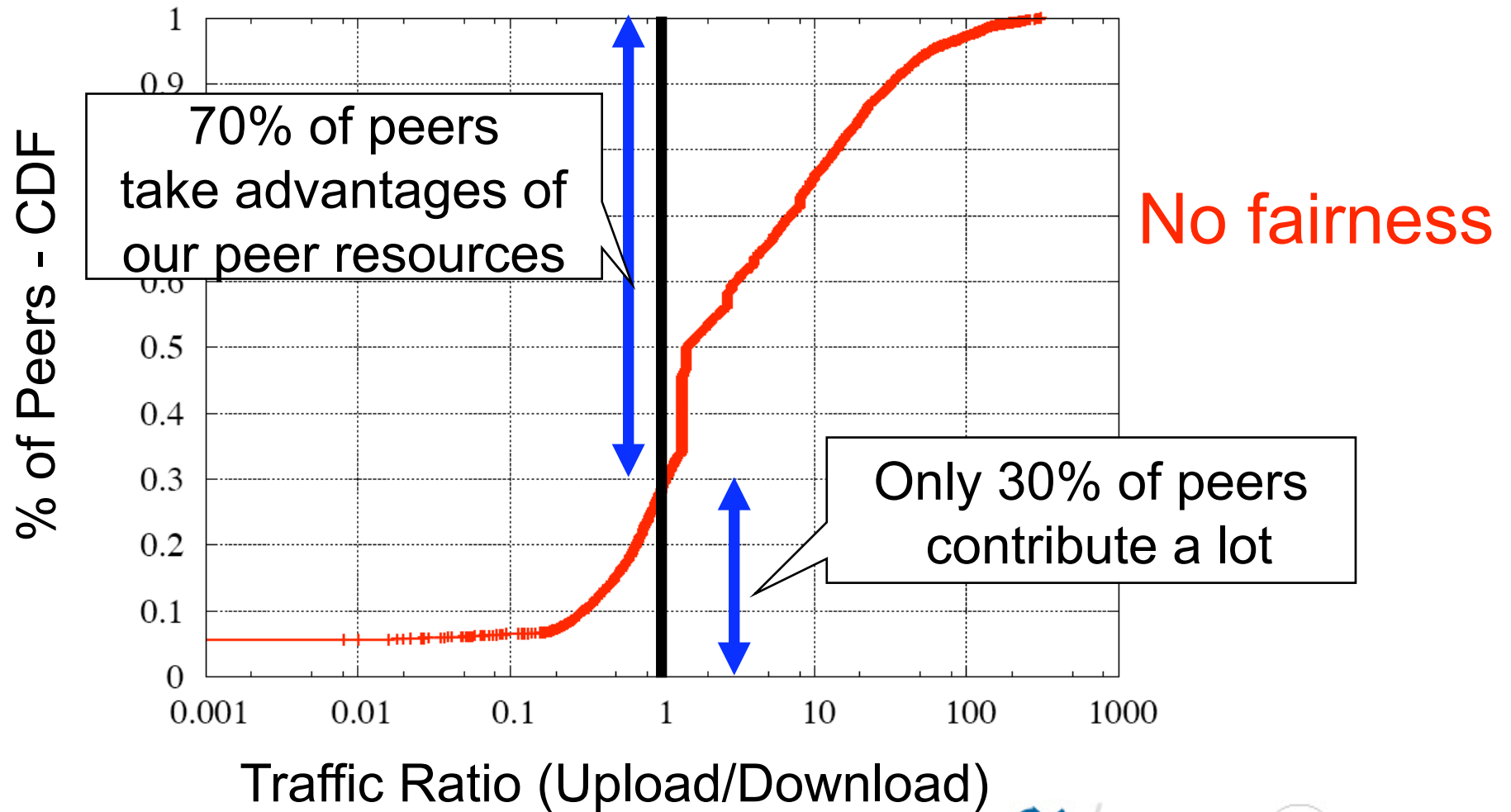
- P2 does not transmit to P1
  - Not because P2 is uncooperative
- Nature of live content
  - Temporal constraints
- Peers synchronize with the data each needs
- No reciprocation with data
- No fairness



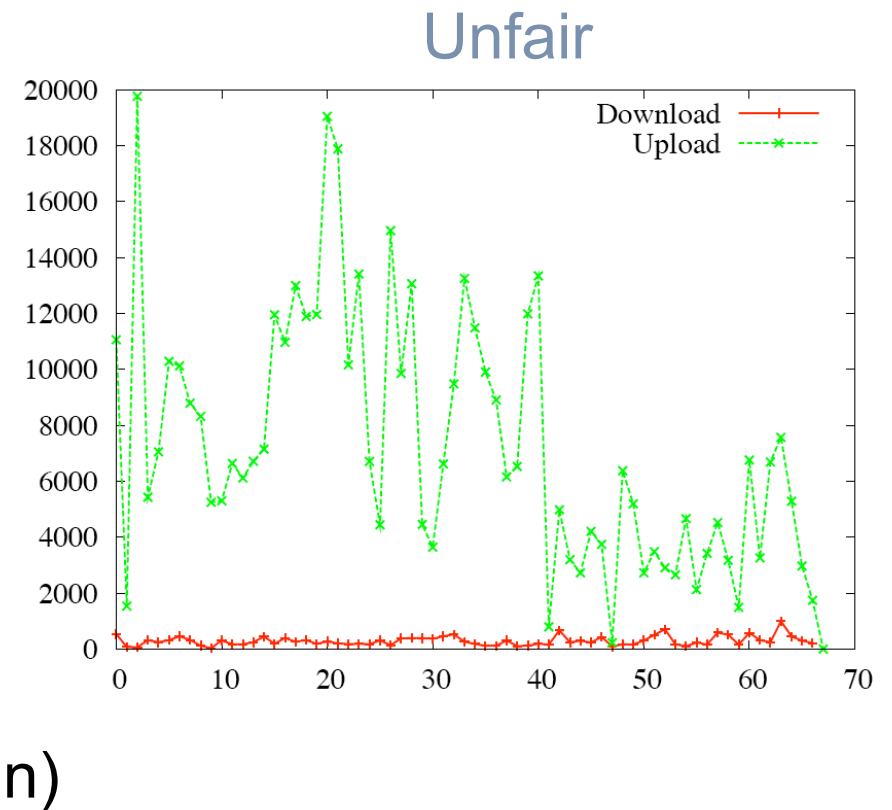
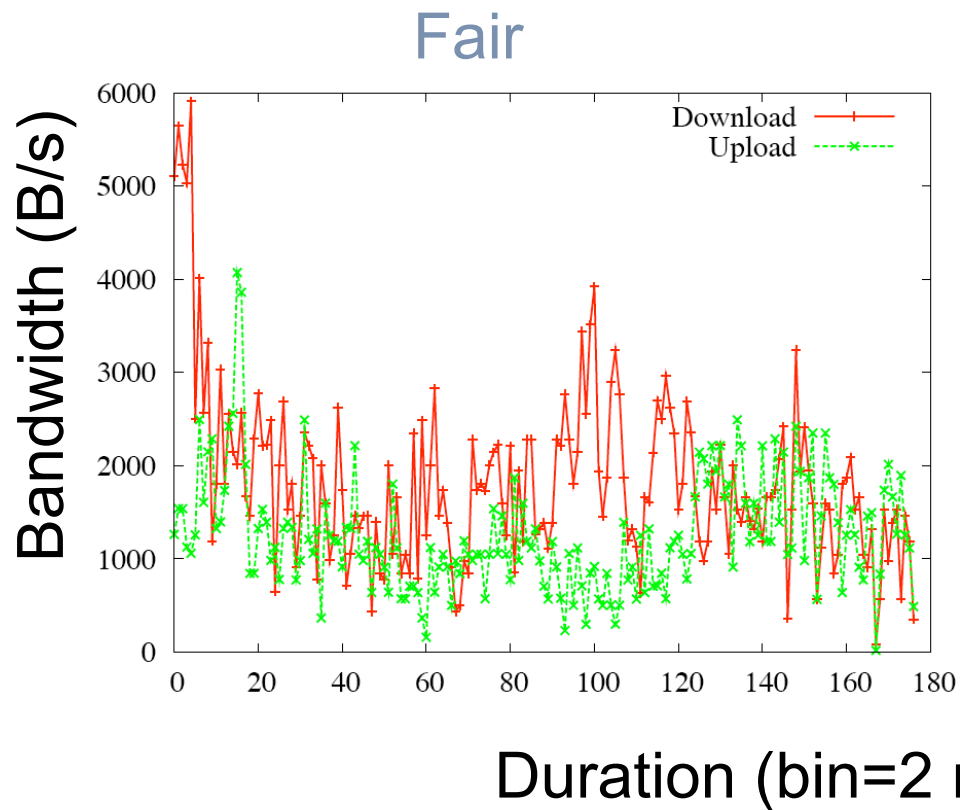
# Measurement of Real Systems

- Passive Measurement of the traffic generated by P2P IPTV applications
  - PPStream
  - Campus Network
  - Live event (soccer game)

# Fairness Between Peers



# Examples of Traffic Exchange



# Measurement of Real Systems

- Fairness is not achieved in BitTorrent-like P2P Live streaming systems
- Need for an incentive mechanism designed for P2P live streaming
- This mechanism must allow all the peers to collaborate and deal with:
  - The continuous nature of the live content
    - No transmission of data reciprocally between peers

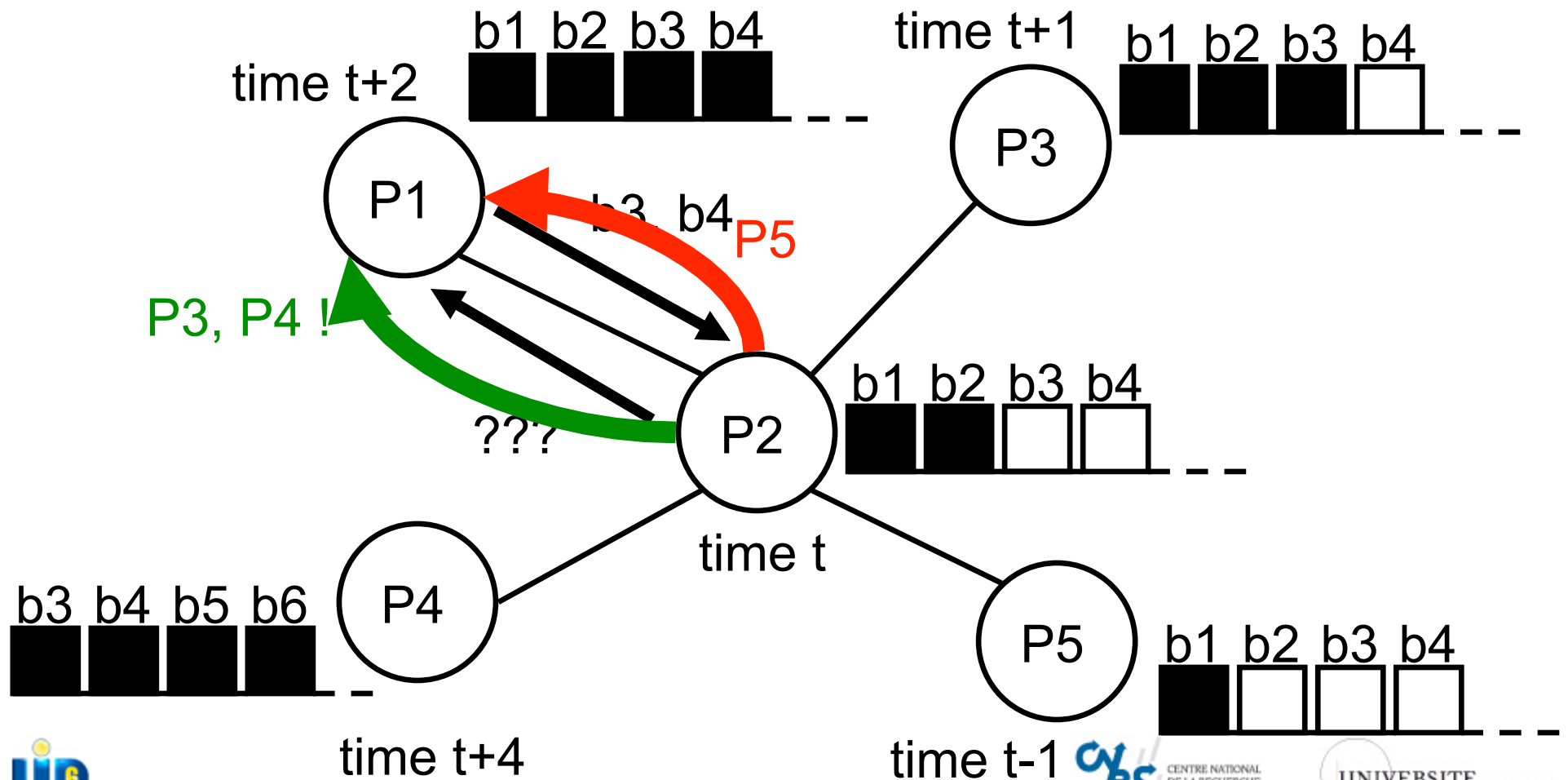
# Towards a novel incentive mechanism for P2P live streaming

- Collaboration of a peer cannot be evaluated on the quantity of data it transmits in return
  - Continuous nature of the media
  - Temporal constraints
- New criterion to evaluate the collaboration of the peers
  - Consuming peer invests in the exchange or not

# Towards a novel incentive mechanism for P2P live streaming

- Consumer peers advertise new peers capable to offer data to their provider peers
- Consumer peers proves their collaboration
  - Help provider peers to discover new sources of data
  - Send indirectly data to their provider peers
  - Continue to receive data from provider peers
- Peers are encouraged to find new peers and to propose them to their data providers

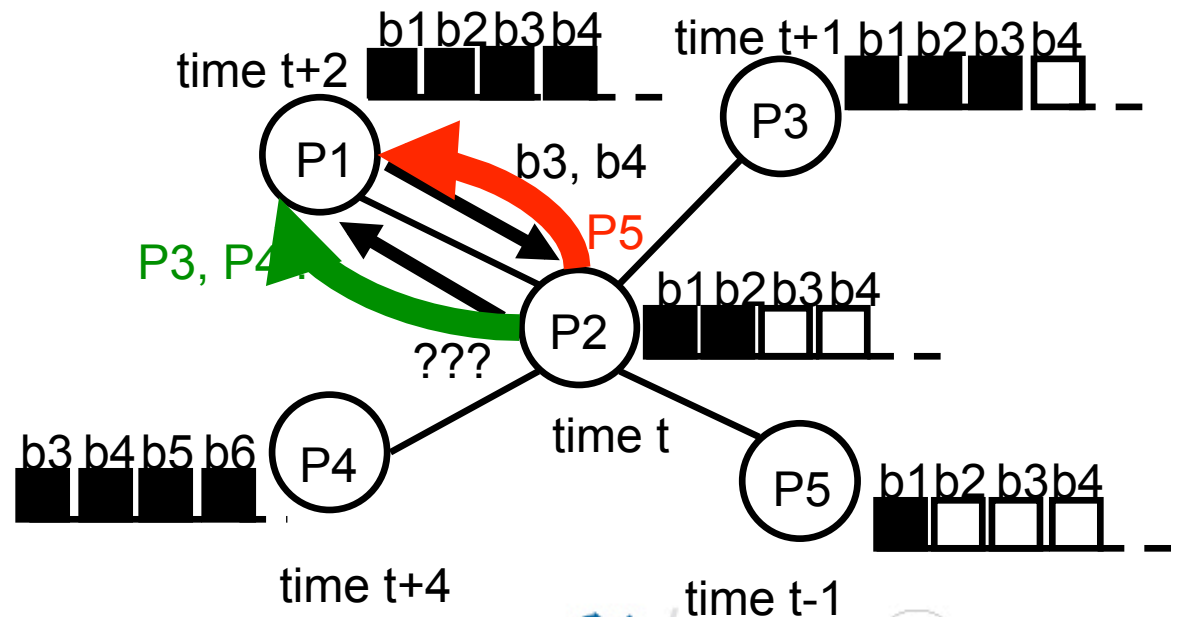
# Towards a novel incentive mechanism for P2P live streaming



# Towards a novel incentive mechanism for P2P live streaming

The reactions of P1 according to P2:

- P4 holds blocks which interest P1
- P3 does not hold blocks for P1 but is a provider to P2
- P3 and P4 are known by P1
- P2 informs P1 about P5



# Conclusion

- Limitations of BitTorrent incentive mechanism for P2P Live streaming
  - Nature of continuous media and temporal constraints
- New incentive mechanism well suited for P2P Live streaming
  - Evaluation of peers collaboration not only based on data
  - Consumer peers collaborate by exchanging control information
- Matches our observations of real P2P IPTV systems

# Future Work

- Evaluation and Validation of our incentive mechanism
  - Simulation on Peersim
  - Cost (overhead)
- Refine the parameters of the mechanism
  - Reaction of the data provider
  - Quality of peers reported
  - Reputation and confidence between peers
- Scheduling algorithm for the organization of data to download (Rarest first)

# Thank You

# Questions?

