Challenges of P2P Streaming and PPSP

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Agenda

- What we have achieved in P2P streaming
- Challenges of P2P Streaming
- Challenges of PPSP in IETF

P2P Streaming Success

- Real-world examples
  - PPLive
    - 110m users, 600+ channels
    - 2 million concurrent peers/6 million altogether in China's 60 Anniversary National Day live broadcasting
    - 20%-30% outside of China (10-15% in US), >200 countries
  - PPstream
    - 70m users, 340+ channels
    - 6 million concurrent peers/10 million altogether in China's 60 Anniversary National Day live broadcasting
  - UUSee
    - 4-5 million concurrent online peers during Olympic Games
    - 2~3 million concurrent online peers in China's 60 Anniversary National Day live broadcasting
  - CNN (OctoShape)
    - Obama inauguration ~300K concurrent peers by OctoShape
  - CNTV
    - China National Network Television for CCTV programs with P2P live and VoD programs, launched since 2010, with a rapid user increase

Is P2P streaming already PERFECT?

No!

A lot of problems to be solved

Challenges of P2P Streaming

- User experience
- Flash crowd
- Delay
- Unpopular content
- Mobile
- ISP-friendly
- Transport protocol
- Testbed

Challenge 1: User experience

- Complaint:
  - Unexpected bill of bandwidth
  - Affect other applications (e.g., Playing games)
  - Affect other users behind the same NAT
  - Occupy disk space
  - …

http://en.wikipedia.org/wiki/BBC_iPlayer

Our initial work

- Testing the NAT response when P2P streaming work
  - RTT to sina.com increase obviously
  - When No. of link increase from 100 to 300, RTT increases from 100ms to 400ms

We must, must, must decrease this kind of impact to users

Otherwise, some day, they will abandon us.

Proposal

- Resource Monitor
  - Bandwidth, CPU, Storage, Buffer…
  - Other apps
  - User activity detection
- Intelligent Interference Minimization Algorithm
  - Adaptive back-off algorithm
  - Optimal resource allocation
- Infrastructure support
  - Deployed Super Nodes
  - Voluntary super-nodes are usually not enough

Peer Upload Limitations

Redistribution factor

（k）Upload/Download

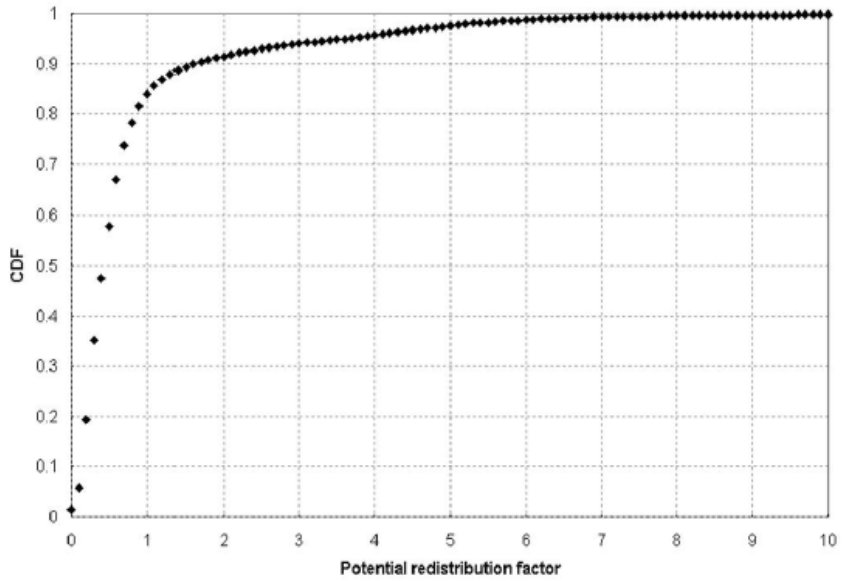


Fig. 2. Achievable redistribution factor.

- Mean: 0.89
- 50% peer < 0.5
- 82% peer < 1

Upload rates are measured between the peers using a specific server located in Europe

NAT Limitations

Different NAT Types

1. open host（the least restrictive ）
2. full cone,
3. IP-restricted,
4. port-restricted,
5. symmetric,
6. UDP-disabled（the most restrictive ）

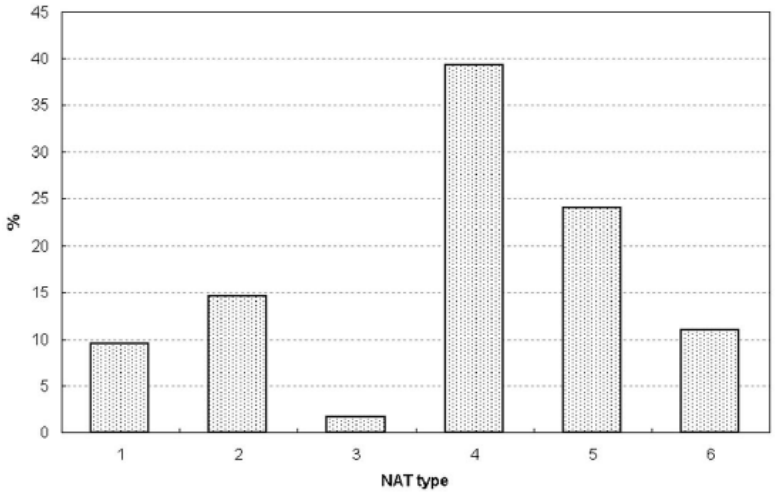
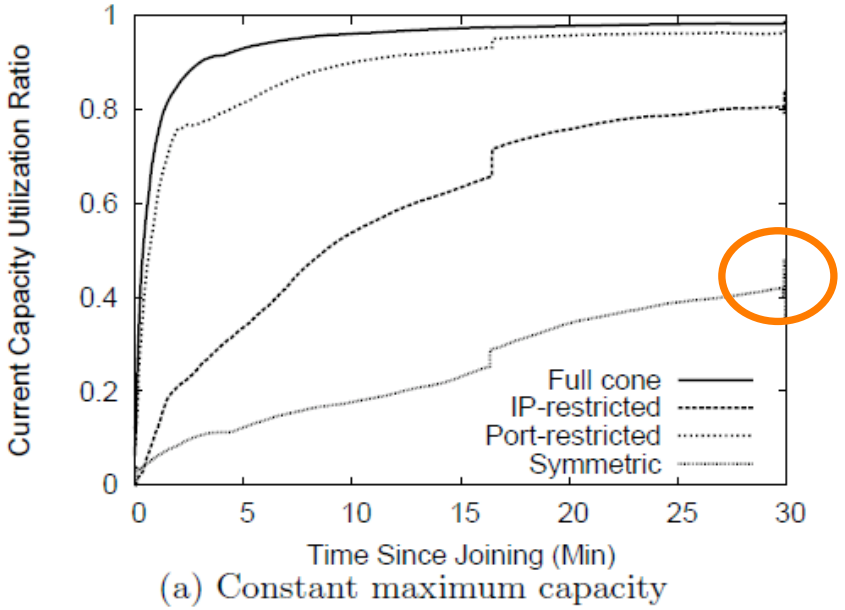


Fig. 4. NAT types.



(a) Constant maximum capacity

NAT capacity utilization ratio in Zetto

Challenge 2: Flash crowd

- Flash crowd is fair common in streaming
  - Big events
  - Abrupt(unreasonable..) Popularity of personal
- Each peer wants to start watching the play immediately
  - They compete, and they all fail
- Not so easy as in P2P file sharing
  - Long delay is unacceptable
- Many concerns from academic field
  - Leighton
  - Seibert
  - Li

Flash crowd in Olympic Games :LiuXiang's withdrawal of 110-meter-hurdle race

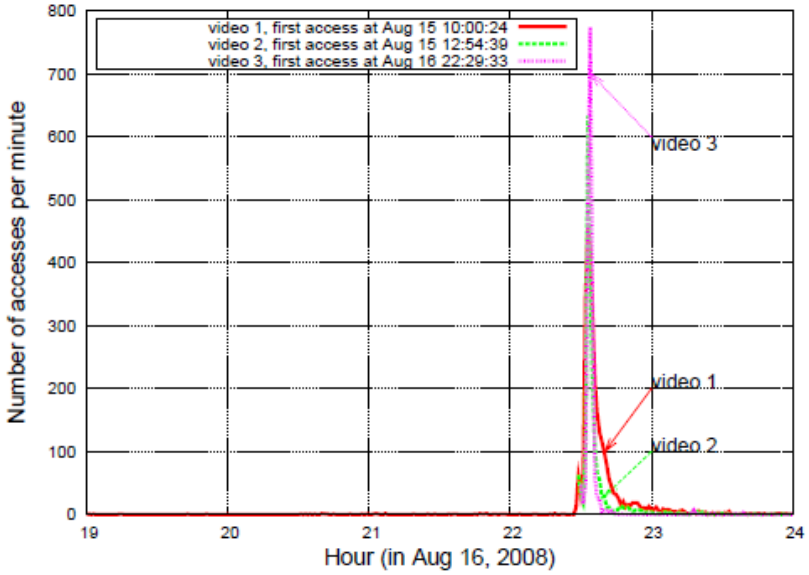


Figure 17: Flash crowd during the men's 100m final with related videos released much earlier

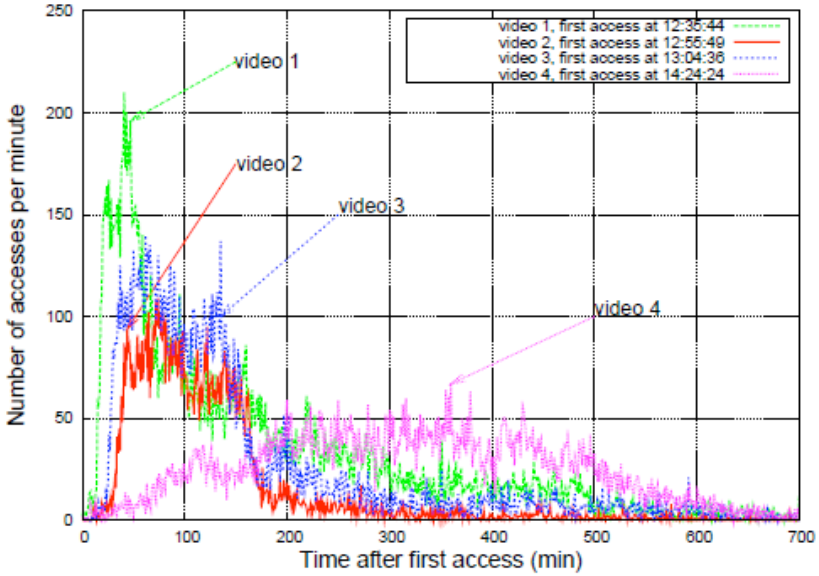


Figure 18: Number of accesses per minute in *Off* for the press conference videos following Liu Xiang's withdrawal on Aug 18

Proposal

- Our work shows there is a capacity limit for system to sustain flash crowd.
  - Related to shock level, the ratio between the peer arriving rate after the flash crowd and that before the flash crowd
- Solution: Increasing the stable peers
  - Admission control
    - Increase the shock level step by step…
    - High capability nodes with first entry
  - Server Assistance

Challenge 3: Delay

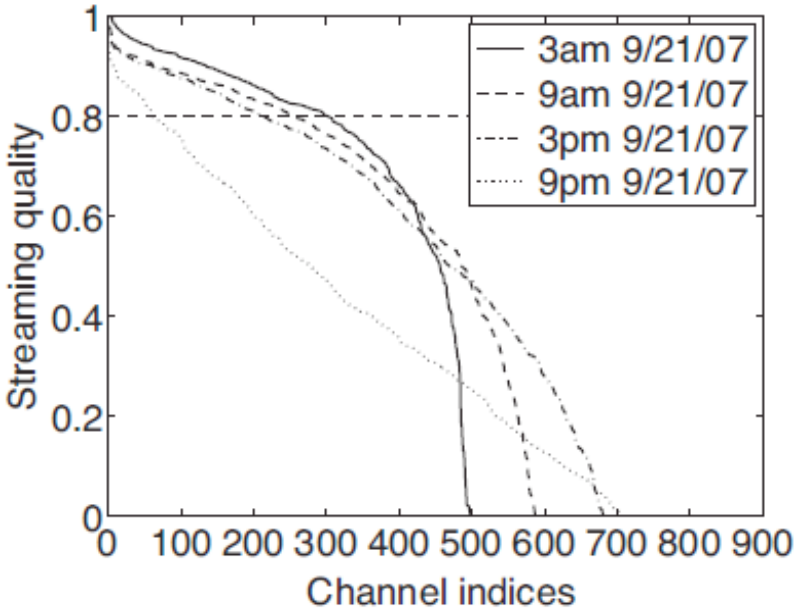
- Delay of current P2P systems is still too large:
  - Pull-based system: 10-20s
  - Push-based system: 5-8s
- Cannot be used for interactive TV

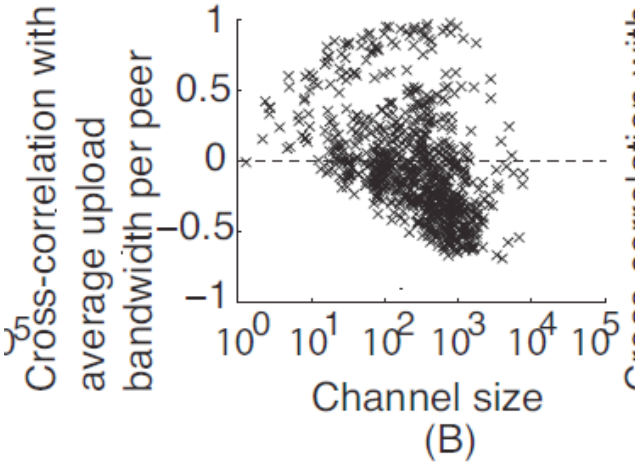
Proposal

- Exploit Super nodes for more stable overlay
  - Multiple layers(or with deployed Super Nodes)
  - Hybrid Push-Pull
  - Closest Parents

Challenge 4: Unpopular content

- Long-tail: Most of video is unpopular
- P2P is not efficient for unpopular content
- UUSee problems in 2007
  - Quality: percentage of high-quality peers in the channel with more than 80% buffered
  - The more contribution, the lower quality





Proposal

- Dynamic allocation resource
  - Server resource coordination
    - Now: Unpopular channels VS popular channels: No difference in resource allocations when peer requests
    - Improved: Server resource allocations inversely proportional to channel popularity
  - Peer resource coordination
    - Count peer resource distribution (hotness/coldness) and allocate the ratio accordingly
  - VUD: View-Upload Decoupling
    - each peer is assigned to semi-permanent distribution groups; independent of what it is viewing.

Challenge 5: Mobile Scenarios

- More and more mobile and wireless peers
  - Have more possibility to support P2P
    - Better CPU, memory and storage
    - Better network bandwidth (esp. more uplink waste for nothing for symmetric links)
  - But…
    - Unsteady network connections
    - Less steady power
    - Different media coding for mobile devices
    - Moving: Other peers can not find the moving peer
      - They contribute less
      - Impact on the quality of the whole system
    - Security
    - …

Some experiments on mobile environments

- China Mobile:
  - Switch ON/OFF for the peers in a PPLive network and monitor the packet loss as well as viewed performance
  - Conclusion: No too much performance degradation because of CACHING in peers
  - Problems: Not applied to a large portion of mobile peers
- NEC European Lab:
  - A hybrid WLAN+3G environment, Groups are formed among peers; Chunks are shared by WIFI within group and by 3G outside group
  - The initial resulting is encouraging.

Proposal

- Heterogeneous environment cooperation
- Adaptive topology learning
- Content caching at AP
- Exploit the broadcast channel
- Select the handoff time according to the resource distribution
- Moving peers fetch late
- …

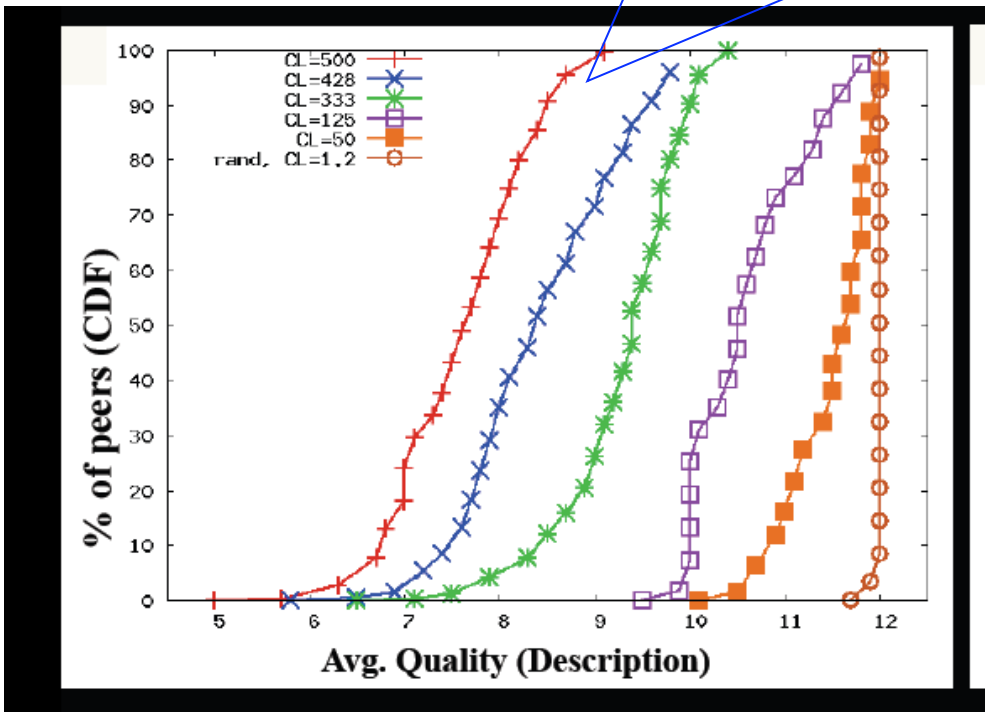
Challenge 6: ISP friendly

Measurements on existing P2P streaming systems

- April 2008,running PPLive, Sopcast and TVAnts in 4 countries in Europe(FR,IT,HU,PL)
- TVAnts and PPLive exhibit a preference to exchange data among peers in the same autonomous system the peer belongs to.
- More and more attempts on this
- But…

Possible Side effect of ISP-friendly

Clustering may lead to performance degradation!!



Adding performance metrics in connectivity selection?

Challenge 7: Transport protocol

- UDP is widely used in P2P streaming NOW
- Change from TCP
  - PPLive:2008
  - PPStream:2008
- If all use UDP, will the Internet collapse as predicted some tens years ago by Sally?
- Seems NOT!
- Why?

Proposal

- Seems that P2P streaming has a different connection model than before
- Multi-to-multi connections
- The network core seems already naturally load-balanced with P2P properties
- Problem lies that how to regulate network edge
  - Neighbor selection
  - Balance among all links' bandwidth
    - Connection number management
    - What's the optimal connection number?
- New protocols are needed?

Challenge 8: Testbed

- PlanetLab is not enough for P2P streaming
  - Over-provisioning on bandwidth leads to sometimes even contrary conclusions
  - Linux version only
  - NAT unsupported
  - Mobile peers
  - …

Proposal

- DSNLab testbed for P2P streaming
  - PlanetLab-based
  - Adding Windows support
  - Adding NAT/private network support
  - Adding mobile support
- This is an ongoing work, welcome to participate

Challenges of PPSP in IETF

- PPSP WG was just approved by IESG yesterday
- PPSP: Peer to Peer Streaming Protocol
  - Tracker protocol
  - Peer protocol
  - Using for hosts (including mobile), existing or new edge infrastructure(Caches, CDN nodes, ISP deployed Super Nodes)

Problems to address

- How to get to know the real-time stream swarm peers and what content chunk they have quickly even there are some Ms of concurrent requests?

- The current best practice is a tracker-based architecture

- Tasks:
  - Tracker-peer communication: For information request/answer to provide suitable peers, esp. in the initial stage

  - Peer-peer communication: For information gossip-like exchange for each other's available stream data status and more neighbor peers it knows besides tracker tells

Open questions on PPSP

- Shall we use the bittorrent protocol as a base?
- Media distribution between peers
  - Would RTP be the best solution?
  - If so, can we use SIP or RTSP to set up the sessions to exchange RTP media taking advantage of ICE?
- Do we need distributed trackers or centralized trackers are enough?
  - There may be confusion on what centralized means
  - How do we perform tracker discovery?
- Perfect privacy protection is a good feature to have but not a mandatory requirement

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Thanks!