Challenges of P2P Streaming and PPSP

Yunfei Zhang, China Mobile
Changjia Chen, Beijing Jiaotong University

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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 60th 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 60th Anniversary National Day live broadcasting
  – UUSSee
    • 4-5 million concurrent online peers during Olympic Games
    • 2~3 million concurrent online peers in China’s 60th 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

\[(k) \text{ Upload/Download}\]

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

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

Fig. 2. Achievable redistribution factor.
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)

NAT capacity utilization ratio in Zetto

Fig. 4. NAT types.
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: Liu Xiang’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
- UUSSee 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
Reference (1)

• Delay

• Flash Crowd

• Mobility
  – C. Li, C. Chen, A Measurement Study of Quality of P2P Streaming System in Mobile Environment, Submitted to Computer Networks
Reference (2)

• Unpopular content
  – D. Guo, C. Chen and Y Chen, Understanding and Searching the Online Video in China, ICCSNA 2009, (PDF)

• M2M
  – Y. Zhao, C. Chen, Modeling Multi-Point Transport Protocol in P2P Networks,Submitted to Computer Communications

• Nebula
  – H. Zheng, Y. Zhang, Y. Chen, etc. Measure and Test Distributed Service in China, AisaFI 2009, (Poster, PPT)
Thanks!