P2P Live Video Streaming

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http://cis.poly.edu/~ross
On-Demand Internet Video

• Youtube
  - User generated content
  - August 2006: 6.1 million, growing at 20% a month; 1.73 user views; 9000 years of user view

• Viacom (MTV)
  - produced content

• Joost
  - Founded by Kazaa/Skype people
  - P2P VoD
Live Internet Video: Vision

• Thousands of live channels
  - TV from hundreds of countries
  - Independent artists
  - Lectures and events
  - User generated from Web cams
  - Hand-held wireless devices

• High-quality image and sound
  - 1Mbps+

• Channel viewed by thousands to millions of users
Live Video Challenge

• How does a popular site distribute
  - a million streams
  - at 1 Mbps
  - in cost effective manner

• From server to 1M clients: 1 terabit/s
  - Cost prohibitive

• Naturally, consider P2P
P2P IPTV: success stories

• Coolstream:
  - 4,000 simultaneous users in 2003

• PPLive:
  - 200,000 users at 400-800 kbps for 2006
  - Aggregate rate of 100 Gbps

• ppstream, UUsee, and many others
Basic idea P2P live streaming

Source of video

tracker

obtain list of peers

peer

trade chunks
@ Polytechnic University

• Infrastructure for measuring P2P live video systems
  - Xiaojun Hei, Jian Liang, Yong Liu

• Mathematical modeling of P2P live streaming
  - Rakesh Kumar, Yong Liu

• Incentives and scalable video for live P2P streaming
  - Zhengye Liu, Yanming Shen, Shiv Panwar, Yao Wang

• Security of P2P live streaming systems
  - Prithula Dhungel, Xiaojun Hei

• Developing our own live P2P video system
  - Pratik Mehta, Salil Siddhaye, Yaochin Wu, Prithula Dhungel, Xiaojun Hei
Measurement Methodologies

• Protocol analysis
  - PPLive, ppstream

• Active crawling
  - Visit all peers in a channel every minute
  - Learn IP addresses of active peers
  - Obtain buffer maps from all active peers

• Passive sniffing
  - Monitors at residences and university campuses
  - Sniff and analyze traffic
Measurement Aparatus

• 30 peers per Linux box
• 5-10 boxes
From Crawler: Popular Channel CCTV3

![Graph showing the number of active peers over time, with peaks on certain days and a trend over the week.]
PPLive: Chinese New Year 2006

![Graph showing the number of peers over time on January 28 and January 29.](image)
Upload and download rates: Home, Popular

![Graph showing upload and download rates over time](image-url)
Upload and download rates: 
Campus, Popular Channel
Time lags among peers
Pollution

• Easy for attacker to:
  - Join the channel
  - Advertise that you have everything
  - Send corrupted chunks to neighbors

• Unsuspecting neighbors forward chunks

• If sufficient fraction of received chunks is corrupted, peer quits channel.
Measurement Results

Figure: Number of peers viewing channel over experiment periods
Incentives (or Why Upload?)

• BitTorrent solves incentives with tit-for-tat:
  – Alice gives lots of chunks to Bob only if Bob reciprocates
  – Incentive to upload: download file faster
• But in live streaming, only need at rate $r$.
  – So why should a node upload at rate higher than $r$?
  – Or upload at all?
• Solution: scalable coding
  – Send description chunks to a neighbor in proportion to the rate you receive chunks from the neighbor.
Incentives: Layered Video

• Generate multiple layers, with each layer divided into layer chunks (LCs)

Layer 3: LC31, LC32, LC33, LC34
Layer 2: LC21, LC22, LC23, LC24
Layer 1: LC11, LC12, LC13, LC14

• Exchange LCs
• Measure download rates from neighbors
• Reciprocate to neighbors based on their contributions
PolyLive

• Our own live P2P streaming system
• Java
• User-generated content
  – from web cams
  – and hand-held devices
• Initially, Flash-centric:
  – Provide a P2P engine for Flash live streaming
PolyLive: Peer Software Architecture

- Start to exchange messages with peers; each Downloader or Uploader is a individual thread.
- Get peer list from Tracker.

![Diagram showing PolyLive architecture with modules and connections.](image-url)
Summary

• Is live video streaming the next big thing?
  - Measurement and monitoring
  - Analytical modeling
  - Prototype development
  - Incentives and security

• Also looking at P2P VoD