SEMINAR RECHNERNETZE UND VERTEILTE SYSTEME

PEER- TO- PEER MEDIA STREAMING

Ildefonso López Marín
University Jaen (Spain)
Overview

> Introduction
  — Definition of streaming
  — Components
  — Services

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Introduction

> Definition of streaming
  — Strategy for distributing multimedia content over the Internet directly on a website or with a dedicated client program

> Components
  — Codecs
  — Protocols
    - UDP
    - RTSP, RTP, RTCP
    - Unicast/Multicast
  — Content Distribution Network: e.g. P2P

> Services
  — Audio: Radio, Podcasts, …
  — Video: TV, VoD, Conferencing, …
P2P Streaming Examples and Implementations

> Multiparty Videoconferencing System [1]

— Desktop videoconferencing
  - Web conferencing
  - No dedicated ISDN lines / runs on normal PCs
  - Increasing need for multiparty videoconferencing

— Challenges:
  - Synchronous delivery of high-volume media content
  - Heterogeneous network conditions
  - Addressing and connectivity
  - Real-time requirements
P2P Streaming Examples and Implementations

- Multiparty Videoconferencing System [1]
  - (1) System Architecture:
    - a) Server implementation:
      - NAT traversal
      - Session setup
    - b) Client implementation:
      - Transport
      - Connection
      - Routing
      - Member
      - Session
P2P Streaming Examples and Implementations

- Multiparty Videoconferencing System [1]
  - (2): Application-Level Multicast Routing
    - a) Source-specific trees have better end-to-end performance than shared trees
    - b) Distributed DV (Distance Vector) protocol cannot make use of bandwidth resource as intelligently
    - c) Incorporating IP Multicast into a ALM scheme can greatly improve end-to-end performance and network resource usage
Design and Evaluation of a P2P IPTV System for Heterogeneous Networks [2]

Description P2P IPTV:

- What is?
  - Internet Protocol Tele Vision, System where a digital television service is delivered using Internet Protocol over a network infrastructure.

- Architecture of IPTV
  - Centralized Architecture
  - Distributed Architecture

- Advantages
  - More content and functionality; Interactivity; VOD; IPTV based Converged Services

- Limitations
  - It is sensitive to packet loss and delays
P2P Streaming Examples and Implementations

> Design and Evaluation of a P2P IPTV System for Heterogeneous Networks [2]

— NTUStreaming, three key components:
  
  1) Partnership formation
  TYPHOON

  2) Robust video coding
  MDC-STHI

  3) Video segment request
  Coded-aware scheduling

source [2]
P2P Streaming Examples and Implementations

> Design and Evaluation of a P2P IPTV System for Heterogeneous Networks [2]
  — Multiple Description Code Evaluation:

STHI
P2P Streaming Examples and Implementations

> Design and Evaluation of a P2P IPTV System for Heterogeneous Networks [2]
  — Multiple Description Coding Evaluation:

STHI
P2P Streaming Examples and Implementations

> PULSE: P2P Live Streaming System [3]

— Definition: Pulse is an unstructured p2p system for live streaming. It is data-driven, receiver-based and it promotes node cooperation through the use of incentives.

— The main goals of Pulse are:

  - Scalability to distribute the content to a large set of peers
  - Flexibility to accommodate heterogeneous peers
  - Robustness to behave well in presence of transient nodes
P2P Streaming Examples and Implementations

> PULSE: P2P Live Streaming System [3]

— Media Streaming:
  - The stream is divided in a series of pieces called *chunks*
  - Every chunk is characterized by a timestamp
  - A FEC coding mechanism is applied to chunks

— The lag reference system:
  - A chunk's lag is given by the difference between its timestamp and the timestamp of the chunk currently being broadcast by the source
  - The position of a node inside the system is given by the lag value of the chunk at the beginning of its sliding window
P2P Streaming Examples and Implementations

- **PULSE: P2P Live Streaming System [3]**
  - Mesh + Clustering + Targeted Altruism = Locality Awareness!

Source

Peer P

Upload-Rich Peers

Upload-Poor Peers

Node Lag

Buffer Range (Trading Window)

Older Data Chunks (Used for Altruism)

Age Limit (P Discards Chunks)

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Network coding in P2P Streaming [4]

- Improves the performance of both peer-to-peer (P2P) and wireless network
- Allows coding at intermediate nodes
- Improves network throughput of multicast sessions
- Reduces the redundancy of bandwidth usage
- Improve resilience to network dynamic
- Is beneficial for large-scale P2P content distribution
- Treats all blocks are equally (with network coding)
Improving P2P Streaming

- Network coding in P2P Streaming [4]
  - Lava: Experimental Testbed for Network Coding in live P2P
    - Gauss-Jordan elimination
    - Architectural design implementation based P2P live streaming protocol, called Vanilla

source [4]
Network coding in P2P Streaming [4]

— Evaluation of Network coding in P2P Streaming with several important metrics:
  - Playback skips:
    Percentage of segments skipped during playback
  - Bandwidth redundancy:
    Percentage of discarded segments
  - Buffering levels:
    Percentage of completely received segments in the playback buffer on each peer

— Concluding remarks:
  - Advantages in P2P Live streaming when peers are volatile and dynamic
Maximizing Tree Bandwidth [5]

How to build a high-bandwidth overlay tree based on underlay information?

- Via two types of tree construction problems on a router-level topology:
  
  (1) Maximum Bandwidth Multicast Tree
  
  (2) Minimum Stress Multicast Tree
  
- Note: To ensure good streaming quality at a host, the incoming bandwidth of the host should be higher than or equal to the streaming bit rate.
> Maximum Bandwidth Multicast Tree [5]

If link bandwidth information is available, a high-bandwidth overlay tree instead of a minimum-stress tree can be constructed.

When MBMT is used:

- Similarly, each time the server randomly adds an adjacent path into the current tree and evaluates the tree bandwidth of the new tree.
- Finally, the server adds the path that leads to maximum tree bandwidth of the new tree.
> Minimum Stress Multicast Tree [5]

In our network model, the underlay topology consists of a set of routers, which are inter-connected by physical links.

When MSMT is used:
- The server checks the paths adjacent to the new host in the overlay path set
- Each time, it adds one path to the current tree, and evaluates the stress of the new tree
- The server then repeats this procedure for a certain number of time and each time checks one path
P2P Streaming examples and implementation:

- **Multiparty Videoconferencing System**: Solution to the challenge for synchronous delivery of high-volume media content.
- **Design and Evaluation of a P2P IPTV**: NTUStreaming is a system that integrates overlay networking and video coding for optimal user experience. This obtains a optimal result in the evaluation.
- **PULSE:P2P live Streaming System**: is an unstructured system designed to support live Streaming.

Improving P2P Streaming:

- **Network Coding in P2P Streaming**: Reduce the redundancy of bandwidth usage, improves resilience to network dynamic, also is beneficial for large-scale P2P content distribution.
- **Maximizing Tree Bandwidth**: It built the high-bandwidth via two types of tree construction problems, MBMT and MSMT.
References

> [1] Chong Luo, Member, IEEE, Wei Wang, Jian Tang, Member, IEEE, Jun Sun, Member, IEEE, and Jiang Li, Senior Member, IEEE, “A Multiparty Videoconferencing System Over an Application-Level Multicast Protocol”.


> [5] Xing Jin, Student Member, IEEE, W.-P. Ken Yiu, Student Member, IEEE, S.-H. Gary Chan, Senior Member, IEEE, and Yajun Wang, “On Maximizing Tree Bandwidth for Topology-Aware Peer-to-Peer Streaming”
Questions?