Research Activities on P2P Streaming Systems and Social Nets

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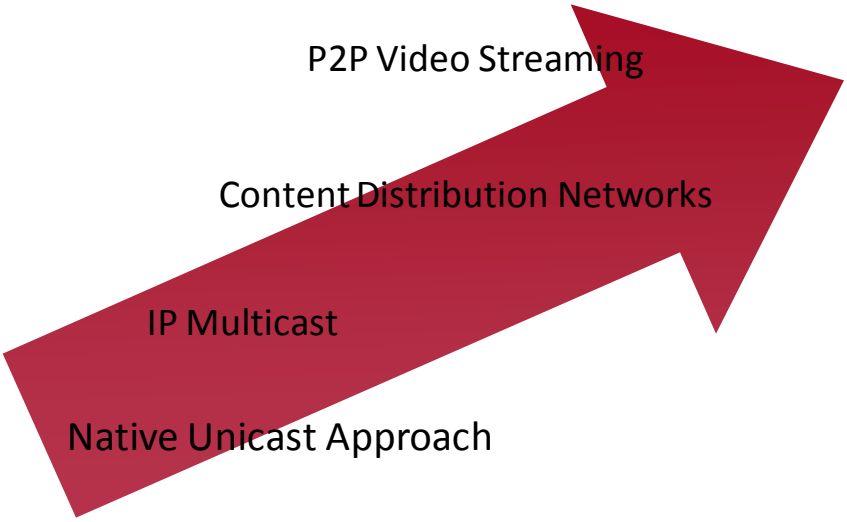
Evolution of Internet Streaming Technology



CDN vs P2P

- Content Delivery Networks
  - – - resources (costs) demanded to servers scale linearly with the number of users
  - – + fully controllable by the content provider and Internet provider
- P2P systems (Peer Assisted)
  - – + resources (costs) demanded to servers, potentially independent from the system scale
  - – - requires high uplink bandwidth at users
  - – - much more difficult to control

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Open issues in peer assisted systems

- peer authentication (access control pricing)
- incentives to cooperation
- robustness against attacks (s.a pollution)
- localization of traffic

In a nutshell how to make peer assisted systems, secure, fully controllable, and network gently?

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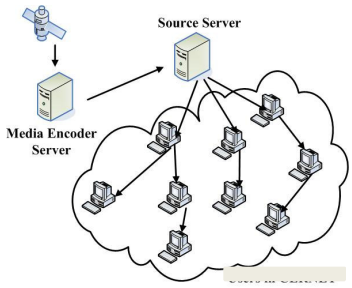
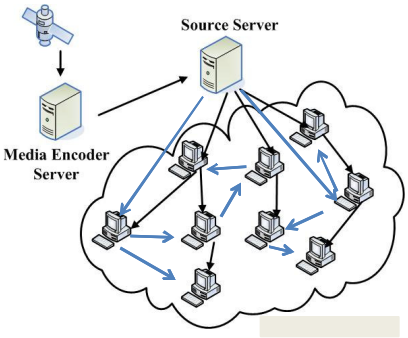
Tree based P2P-TV systems

- Different peers are organized in a tree structure routed at the source
- The content is distributed along the tree



Multi tree P2P-TV systems

- The source adopts a multi-description encoder
- Each description is distributed on a different tree



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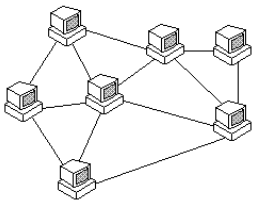
Unstructured Systems

- peers are arranged according to a generic highly connected network
- the stream is subdivided in portions called *chunks*
- each chunk is distributed along a possibly different spanning tree (SP)
- SP are selected using simple random fully distributed algorithms



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Scheduling algorithm at nodes

- Chunks are distributed through the network using a swarm like (epidemic) approach
  - as soon as, a peer obtains a new chunk c, it will offer c to its neighbors
  - Chunks are not propagated perfectly in order; however chunk timing is critical (due to the application requirements)
  - Every chunk has a deadline after which it is not useful (this deadline is related to the play-out buffer)

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Pros and Cons of Unstructured Architectures

+ fully resilient to churning
+ no need of centralized control
+ efficient to exploit the bandwidth
- larger delays in delivering information
- very difficult to control and predict the performance

NAPA-WINE application is unstructured

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Typical assumptions

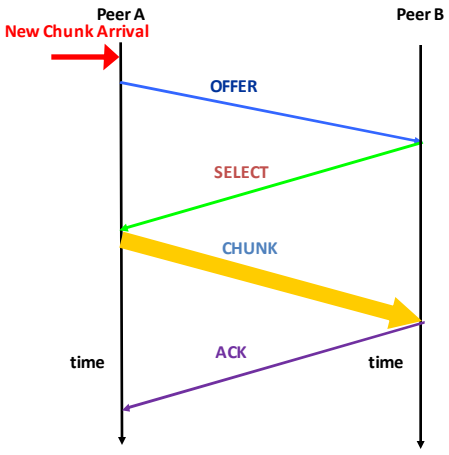
- Systems are bandwidth bottlenecked at the edges (upload BW of peers)
- The network is transparent (it introduces just a delay)

Challenges in unstructured P2P

- Overlay topology
  - How to select neighoors
  - Which is the impact of different overlays (random graphs) on system performance?
  - How to distribute chunks on top of the overlay topology
    - Simple epidemic schemes
    - Understanding the impact of different possible choices
    - Stochastic models, constrained epidemic processes over RG

Signalling Thread

- A peer publishes the set of chunks it possesses through an ***offer*** message.
- Peers specify the chunk they are interested in with a ***select*** message.
- Once the select message is received, chosen chunk is transmitted (over UDP).
- An ***ack*** is sent back once chunk is received



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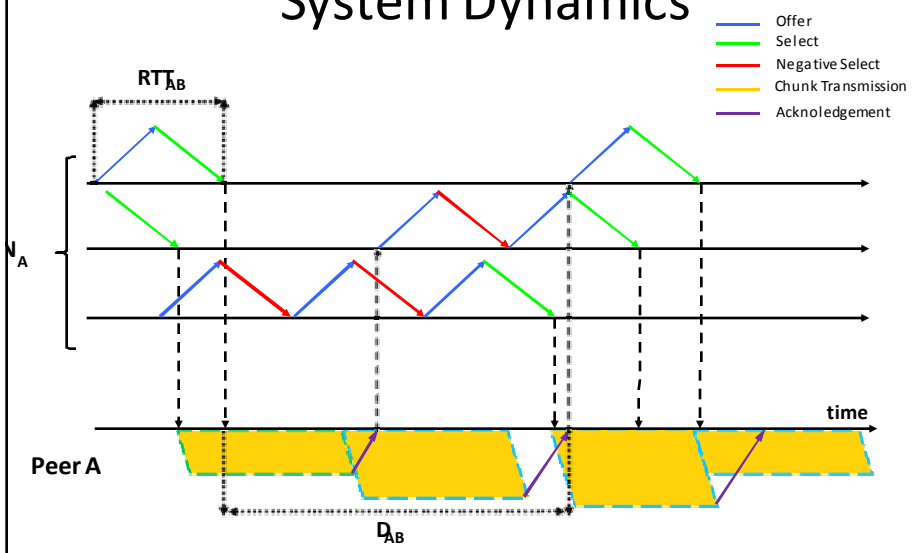
System Dynamics



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Logical topology

- The logical topology is a directed graph, every node chooses its K in-neighbors (parents).
- It can be built either exploiting repository information gossiping mechanisms (Newscast)
- Every T sec. peer p updates the list of in-neighbors NI(p). At every update, NI (p) is the result of two separate filtering functions:
  - one that selects the peers *to drop,*
  - *another* one selecting parents *to add.*

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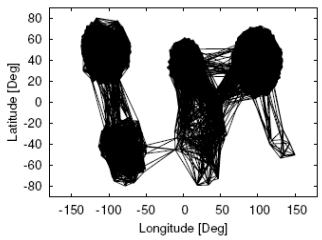
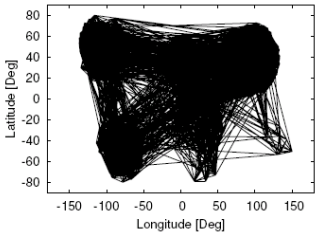
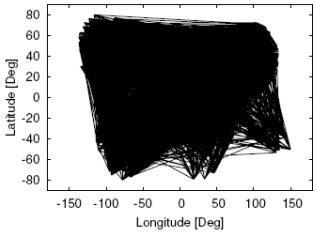
Examples of topologies



RTT-RTT



RTT-Random



Random-Random

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Winestreamer/Peerstreamer

- Available at http://peerstreamer.org

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Team

- Stefano Traverso
- Robert Birke
- Daniele Croce
- Richard Lobb
- Ana Paula Couto da Silva
- Michela Meo
- Marco Mellia
- Emilio Leonardi

Beyond TV: VOD

- P2P assisted systems can be explouited also to support VOD applications:
  - No single source (many possible seeds)
  - Asynchronous service (users are watching different segments of the movie)
  - Content search issues
  - Planning/Prefetching of contents

Our research on VOD

- We have developed some performance models of simple VOD systems
  - Our models based on the theory of Martingales and Random Walks (Lundberg bound)
  - Our model allows to characterize qualitative behavior (self sustainability of VOD applications) when systems grow large
  - **Team:** Delia Ciullo, Valentina Martina, Michele Garetto (Unito), Glianluca Torrisi (CNR-IAC), Emilio Leonardi

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Social Networks and Graphs

- Large graphs evolving over time,
  - several properties have recently been observed
    - Densification, diameter shrinking, etc.
- Challenges:
  - understanding the origin of such properies
  - Defining flexible stochastic models (dynamic random graphs) that exhibith such properties

Other related problems

- Sampling graphs in an unbiased fashion
  - crawling
  - How to infere properties on the whole graph through crawling (for example, graph dimension, birthday paradox)
  - **Team:** Valentina Martina, Michele Garetto, Paolo Giaccone, Gianluca Torrisi, Emilio Leonardi