Network Friendly P2P-TV: The Napa-Wine Approach

This full text paper was peer reviewed at the direction of IEEE Communications Society subject matter experts for publication in the IEEE P2P 2010 proceedings.

# Network Friendly P2P-TV: The Napa-Wine Approach

L. Abeni[1], Á. Bakay[4], M. Biazzini[1], R. Birke[2], E. Leonardi[2], R. Lo Cigno[1], C. Kiraly[1], M. Mellia[2], S. Niccolini[3], J. Seedorf[3], T. Szemethy[4], G. Tropea[5]
[1]University of Trento, Italy; [2]Politecnico di Torino, Italy; [3]NEC Laboratories Europe, Germany; [4]Netvisor Ltd, Hungary; [5]LightComm s.r.l, Italy

## I. Background & Scenario

P2P-TV systems have become part of the Internet landscape[1]. The architecture of these (normally proprietary) applications is generally receiver-driven, in that receivers actively search for suitable peers to download from, trying to maximize their performance. This results in very aggressive applications that generate huge and non optimized traffic loads.

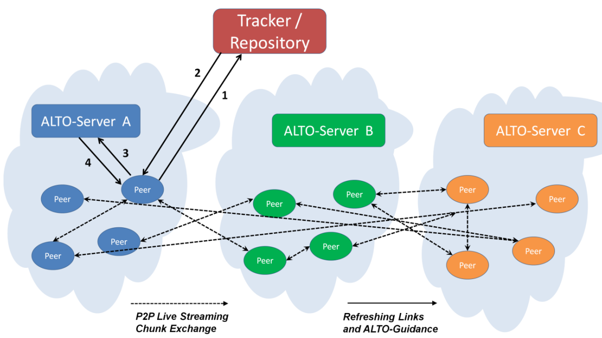


Fig. 1. Logical architecture of a P2P live streaming system interacting with an ALTO server

The Napa-Wine EU project[2] proposes an architecture where P2P-TV clients exploit network measures to reduce their network footprint and, if available, exploit ALTO-like services to optimize topology and performance, and to minimize the overall network load. ALTO[3] is a proposal for supporting the interaction between network operators and P2P applications, whose goal is providing applications with enough information on the network structure to enable the optimization of the overlay topology and the content dissemination, while minimizing network costs. Fig. 1 pictorially represents the logical structure of P2P Live Streaming applications using ALTO for optimized peer selection. Each peer, when discovers new peers to update its neighborhood, sends the list of these candidates peers to an ALTO server, which returns either a sorted list of the candidates, or the same list with some metrics associated.

## II. The Napa-Wine Client

Fig. 2 presents the functional architecture of a Napa-Wine P2P-TV client, which is based on chunkization of the media and swarming on a generic mesh overlay. The client is based on generic libraries we developed, and is organized in different modules, which are briefly outlined in the following.

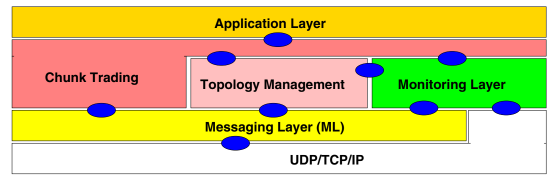


Fig. 2. The functional architecture of a Napa-Wine P2P-TV client.

**User Layer.** It is the module in charge of ingesting and rendering the media. It does support different encoding, but most of all it takes care of smart chunkization of the stream, so that priority diffusion can be implemented by schedulers.

**Topology Management & ALTO Interaction.** Building the overlay for a real-time P2P application is one of the most critical tasks. This module takes care of optimizing the overlay taking into account both application-level performance and network-level costs, also interacting with an ALTO server to obtain information that cannot be accessed at the application level (e.g., link costs).

**Chunk Trading.** The exchange of chunks on the overlay requires both signaling capabilities (e.g., to exchange buffer maps) and scheduling capabilities to optimize the diffusion of chunks. On the one hand, this means careful selection of chunks so that they diffuse evenly and, on the other hand, it means selection of peers based on network-level metrics to meet performance goals while minimizing the network footprint.

**Monitoring Layer.** Metrics like the RTT, the number of hops from other peers, the available bandwidth, etc. requires network-level measures, which are implemented in this module. Some metrics can be retrieved from an external repository instead of measured locally.

**Messaging Layer.** An abstraction of the networking interface is provided by the ML, so that other modules do not have to take care of detailed networking functions like NAT traversal, shaping (if required), peer naming, chunk and message segmentation and reassembly, etc.

The Topology Management and Chunk Trading are implemented on top of a set of generic libraries (GRAPES – Generic Resource Aware P2P Environment for Streaming) which provide all the basic functionalities needed for peer sampling, for chunk scheduling, for exchanging buffermaps and chunk ID sets, for sending and receiving chunks, etc. The

This work is supported by the European Commission through the NAPA-WINE Project (Network-Aware P2P-TV Application over Wise Network – www.napa-wine.eu), ICT Call 1 FP7-ICT-2007-1, 1.5 Networked Media, grant No. 214412

[1]See for instance http://www.pplive.com, http://www.soapcast.com, http://www.tvants.com, and many others.

[2]See http://www.napa-wine.eu for details

[3]"Application-Layer Traffic Optimization (ALTO) Problem Statement," IETF, RFC 5693, Oct. 2009.

978-1-4244-7141-6/10/$26.00 ©2010 IEEE

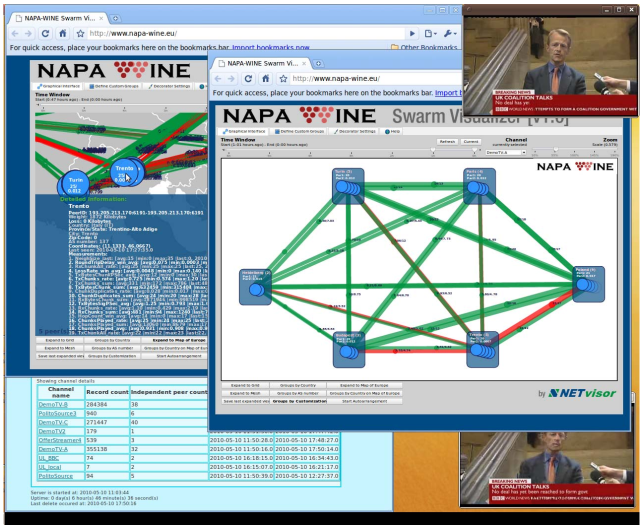

Fig. 3. Real-time visualization of the overlay structure and swarm status

GRAPES libraries only depend on some basic functionalities for sending and receiving messages, and the Messaging Layer described above has been used for this purpose. Programs based on GRAPES just need to implement some basic logic gluing the libraries' functionalities together (this is generally implemented as a simple control loop receiving messages from the network and passing them to the libraries).

## III. Demonstrations & Measurements

The goal of this demo is to show the impact of various P2P streaming options and the efficiency of the Napa-Wine approach (compared to more traditional approaches) by running real streaming clients in realistic conditions. To make this comparison possible, the software developed in Napa-Wine is highly modular and configurable, allowing the user to test different topology management and chunk trading techniques developed within the Napa-Wine project, as well as to configure it to mimic other chunk/peer selection strategies known from literature. The Napa-Wine P2P-TV clients (with different dialects and versions, testing the impact of different policies and architectures) are already running over the Internet in about 100 physical nodes hosted by the project partners[4], and our demonstration reproduces the most significant results achieved through these tests. To this end, some live streams are distributed over the Internet. TV sources are DVB channels transcoded directly from standard terrestrial and satellite distribution systems, and the video quality can be selected to run experiments with different bitrates and frame sizes (one of such possibilities is to distribute the DVB stream without transcoding).

Since large scale, distributed experiments over the Internet are complex, and measures collection is a challenge in itself, we developed an ad-hoc repository for the collection of data and the visualization of the system properties and measures.

[4]Each physical node can host more than one logical peer, so that large scale experiments can be run easily

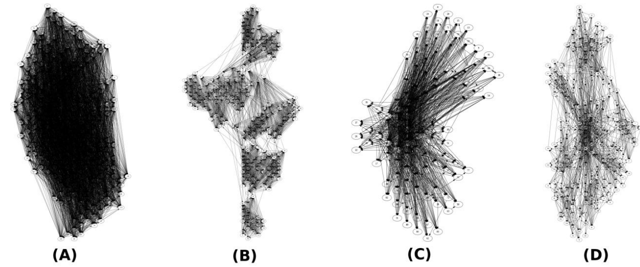


Fig. 4. Example of visualizing the effect of ALTO guidance on the overlay topology

Fig. 3 shows example screenshots (red connections are suffering from chunk losses). Measured quantities can be sampled at different rates; they include the swarm topology, traffic volume between peers, chunks missing at each peer, packet losses at the peers' network interface, etc. In addition, all measurements from the Monitoring Layer can also be pushed to the repository and displayed there. During the demo, both current measures and data stored in the repository will be presented, explained, and commented, showing the performance of different P2P streaming algorithms and solutions.

Given the configurability of Napa-Wine software, ALTO-guidance and different ALTO peer selection strategies can be selected live during the demo, and the effects can be evaluated with the Swarm Visualizer from the repository. For instance, Fig. 4 shows the resulting overlay topology in case A) of completely randomly chosen peers, and B) - D) when peer selection is based on various ALTO strategies. In addition, the demo will display the resulting network layer costs for a given topology, demonstrating the extent of backbone traffic cost reduction with ALTO strategies.

Finally, the demo will also give insight into the behavior of the peers and the underlying GRAPES libraries, as a function of the selected chunk trading logic and protocol, network conditions, activated network measurements from the Monitoring Layer, and the availability of external information sources (ALTO). Fig. 5 shows an example of these peers insights, where the chunk buffer of one peer can be observed evolving at run-time while chunks are exchanged.

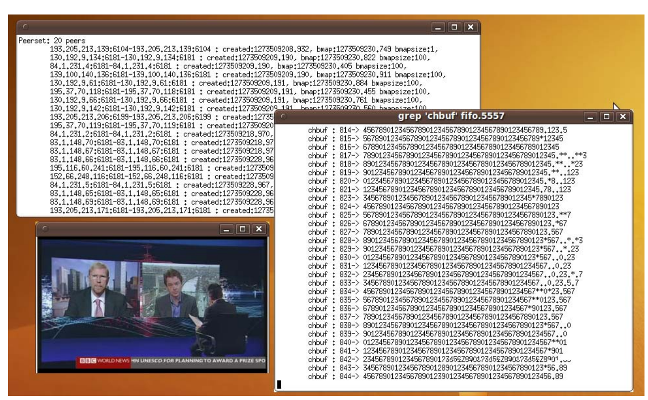

Fig. 5. Real-time insight into peer status