

PhD Thesis with EasyBroadcast (Nantes, France)

Data Mining and Optimization of multi-content distribution in hybrid P2PWeb networks

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Context:

Internet has deeply altered the way TV broadcast is performed. This results from the emergence of Over The Top (OTT) actors whose applications fill the Internet pipes without owning them (this role being devoted to ISPs). Netflix, Google and the like have indeed made VoD services popular at a large scale.

Video contents now represent the biggest share of Internet traffic in terms of volume. Netflix is responsible for 71% of the bandwidth consumed at peak hours in the US, a two-fold increase as compared to 2011, according to the last quarterly report of Sandvine [14]. On average, Netflix consumed 35,2%, followed by YouTube (17,5%) and Amazon Video (4,3%). This heavy trend points toward the need to efficiently manage the network bandwidth. This issue becomes even more crucial with the advent of new technologies like UltraHD, 4K and HDR (High Dynamic Range).

New protocols and encoding techniques have been proposed to enhance the video quality and user experience. Among them, adaptive streaming enables to dynamically adapt the video quality to the available bandwidth. This continuing race towards higher quality leads to ever increasing bandwidth costs for the content providers, especially at peak hour. The legacy client/server (C/S) model, with central servers backed by a CDN (Content Distribution Network) network can lead to congestions when the traffic demand has not been correctly estimated. An alternative approach is to rely on the P2P paradigm so that service can scale with demand.

The P2P paradigm now appears as a viable complementary solution to the traditional C/S model, resulting in P2PWeb protocols [1]. Akamai uses a P2P client, Netsession, since 2010,

which interoperates with its CDN network [2]. In 2013, 25 million users were using Netsession. While Netsession is mostly used to distribute software updates, a merit of this study is to show that an hybrid P2P/CDN performance can be kept on par with the one of a pure CDN network. Another emblematic example the Livesky system of ChinaCache, that leverages an hybrid approach to serve videos up to 10 million users simultaneously [3].

NetSession and Livesky both prove the feasibility, at a large scale of a hybrid approach. Still, they require to install a dedicated client application, which is a major drawback. To address this issue, the WebRTC [15] standard has been developed since a few years. The P2PWeb paradigm is a hybrid approach that leverages the WebRTC standard and enable to benefit from the advantages of the P2P and C/S paradigms, without the burden of installing and updating a dedicated client. In a typical P2PWeb distribution network, the metadata (which content is currently visualized, quality, geolocation of the client, ...) is also decentralized. One part is on the server of the content provider, one part is distributed around the pairs and a last part is on the servers that act as managers of the P2P part of the network.

EasyBroadcast, a start-up company located in Nantes that proposed the P2PWeb protocol [1], has developed a library that leverages this protocol to distribute live and VoD contents. The present PhD proposal is focused on the optimization of hybrid distribution networks in a multi-client (fixed, mobile under Android or IOS) and multi-access network (fixed, 3G/4G) scenario.

Milestones of the thesis

- 1) Scientific and technical state of the art. The state of the art should cover the studies that demonstrate the interest of a hybrid CDN/P2P approach [2,3,10]. The candidate will need to get familiar with the WebRTC standard and the solutions developed by EasyBroadcast. A good knowledge of modern video content distribution techniques such as HAS (HTTP Adaptive Streaming) is also important. HAS enables a client to choose the appropriate (in line with its current network conditions) quality of the next video segment; the video being pre-encoded at various quality levels [4]. The algorithm that dictates the choice the quality by the client is a highly debated topic [5,6] in a unicast context and shall be revisited in a hybrid CDN/P2P scenario. As the hybrid approach requires to use the uplink of the client, several studies have focused on its acceptability [8,9] and shall be reviewed in the initial state of the art.
- 2) Setup of a test platform. To test the algorithms that will be developed during the thesis, the candidate will have to build a test platform that should be as realistic as possible and that should enable reproducibility of the experiments. The open approach advocated in [7], VideoBench, that offers a modular platform, could constitute a good starting point. It is important to assess if it can be adapted to the hybrid case of the thesis or if its principles can be used to enhance the internal test platform of EasyBroadcast. QoS (Quality of Service) and QoE (Quality of Experiments) aspects should also be taken into account (to know which metrics to measure in the testbed) as they are especially important in the case of video distribution.
- 3) The core of the thesis will consist in developing algorithms to manage, in an optimal manner, a hybrid video distribution network. Given the centralized vision of the manager, one will seek to formulate algorithms to maximize the utilization of the network bandwidth. These algorithms could be made of static rules, e.g. to group together mobile clients from the same ISP or, in contrary, to maximize diversity by fostering cooperation among mobile and fixed users depending on their upload capacity [13]. Adaptive approaches should also be considered that take into account the exact fraction of clients in

each category. They could enable to recommend appropriate changes in the quality of the downloaded segments, so to maximize the end user QoE.

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