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Large-scale measurement experiments of P2P-TV systems insights on fairness and locality

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ABSTRACT

P2P-TV is an emerging alternative to classical television broadcast systems. Leveraging possibilities offered by the Internet, several companies offer P2P-TV services to their customers. The overwhelming majority of these systems, however, is of closed nature, offering little insight on their traffic properties. For a better understanding of the P2P-TV landscape, we performed measurement experiments in France, Japan, Spain, and Romania, using different commercial applications. By using multiple measurement points in different locations of the world, our results can paint a global picture of the measured networks, inferring their main properties. More precisely, we focus on the level of collaboration between peers, their location and the effect of the traffic on the networks. Our results show that there is no fairness between peers and that is an important issue for the scalability of P2P-TV systems. Moreover, hundreds of Autonomous Systems are involved in the P2P-TV traffic and it points out the lack of locality-aware mechanisms for these systems. The geographic location of peers testifies the wide spread of these applications in Asia and highlights their worldwide usage.

1. Introduction

Peer-to-peer video live streaming applications (P2P-TV) emerged recently as a new framework to deliver live video such as television over the Internet. The quick spread of these applications surprisingly shows that user oriented technologies, based on collaboration between similar users without a central control entity, are capable to deliver delay sensitive multimedia content. As a consequence, the Internet counts today several of these applications such as PPSTream [1], PPLive [2], SOPCast [3], TVUPlayer [4] or TVAnts [5]. Millions of users located all over the globe are involved and hundreds of channels can be watched live.

The P2P model, essentially known for its scalability, is a practical solution for broadcasting live events or TV shows to a large number of receivers without any deployment cost as it is the case with content distribution networks (CDNs) [6]. Nowadays, P2P traffic contributes greatly to the Internet traffic [7]. The same observation applies on video streaming traffic generated by platforms

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such as YouTube [8]. Thus, P2P-TV applications that combine these two technologies are expected to account for a large part of the Internet traffic.

However, the main problem remains in characterizing the unknown effect of P2P video streaming traffic on the Internet and on Internet Service Providers (ISPs) networks. It was already shown that the traditional P2P file-sharing traffic is a serious threat for ISPs [9]. Nevertheless P2P video streaming traffic, which consumes a lot of bandwidth resources and is very sensitive to the end-to-end delay, is a more intriguing case. Moreover, the fact that television services target a huge number of users spread worldwide further complicates traffic engineering tasks for ISPs. Therefore, it is of a great significance to better characterize the impact of P2P-TV traffic on the Internet and ISPs networks [10].

Numerous P2P-TV measurement experiments focused mainly on the reverse engineering of commercial applications [11–13]. Because most of these experiments studied the traffic from a single measurement point, as it was the case with our previous work [14], the main goal of these works was to infer the underlying mechanisms or architectures used by these proprietary applications. However, these applications are used at the planet-scale and the geographic location of peers, the users' interest in content according to its location, and their Internet access environment have an impact on the behavior of users and the properties of collected traffic.

In this paper, we present our large-scale measurement experiments of P2P-TV systems. We collect the traffic from multiple measurement points located on both sides of the world: in France, Japan, Romania and Spain. Through these measurement experiments, we study the overall P2P-TV networks and extract new characteristics relevant for ISPs and application designers. We study the global organization of the peers and the amount of traffic they exchange between them. We also study the distance among them and discuss the number of ASes involved in the traffic and the impact on ISPs. We analyze the geographic distribution of users and the effect of the content on the P2P-TV population.

The contribution of this paper can be summarized as follows: (i) we perform large-scale measurement experiments of P2P-TV systems that lead to uncovering the following drawbacks; (ii) the lack of fairness between peers in exchanging data. This is an important issue for the viability of P2P systems, which mainly relies by nature on the reciprocal contribution between peers; (iii) the lack of locality-aware mechanisms that makes P2P-TV traffic a dilemma for ISPs since hundreds of ASes are involved in the traffic; (iv) we also provide a comprehensive study on the geographic location of users and the impact of the content on the population of P2P-TV users.

The remainder of this paper is organized as follows. In Section 2, we present our measurement experiments, the experimental testbeds, and the measurement methodology. We also describe the collected traces and their main properties. The results of our measurement experiments and traffic analysis are presented in the following sections. Section 3 analyzes the exchanges of traffic between peers, while Section 4 focuses on the locality of peers. The geographic distribution of peers is emphasized in Section 5. Section 6 discusses the related work. We conclude this work in Section 7 and present our research perspectives.

2. Measurement experiments

In this section, we present the two sets of experiments that have been conducted to collect the data analyzed throughout the paper. First, we describe our testbed located in France and Japan. Then, we introduce the second testbed in Romania and Spain.

2.1. Japan–France testbed

For this measurement experiment, we passively collected the traffic from multiple points located in France and Japan. We focused on the most popular P2P-TV applications, namely PPSTream, TVUPlayer, SOPCast and TVAnts. We selected these applications according to our feedbacks and those from the online community [15]. During our experiments, we measured live soccer games because such events exhibit a real interest to be watched as they happen. There is also a large community of P2P-TV users for this purpose.

Our measurement testbed is described in Fig. 1 and is composed of two distinct parts situated in France and Japan. In each part, we collect packets by using PCs equipped with 1.8 GHz CPU, common graphic card capabilities, and Windows XP. For each of the four measured applications, we performed an experiment involving a different number of PCs according to their availability (five to seven PCs at the same time). Three or four PCs were situated in the UPMC campus network in France and were directly connected to the Internet through a 100 Mbps Ethernet link. We used two to three PCs in the campus network of the University of Tokyo in Japan, also directly connected to the Internet (Ethernet 100 Mbps). During each experiment, all the PCs were running the same P2P-TV application as well as `Windump` to collect the packets. All the video bitrates were 400 Kbps.

Table 1 summarizes the collected traces (publicly available on [16]). All the traces have the same duration of 2 h 45 min. This duration is slightly larger than a soccer

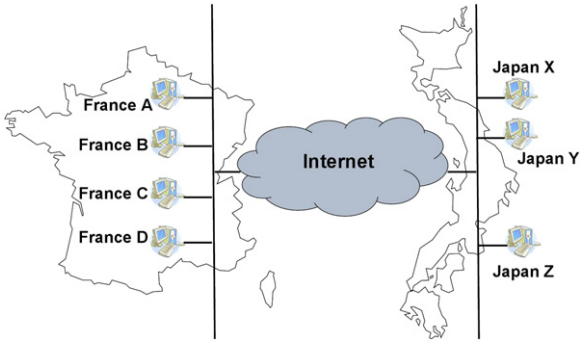

Fig. 1. Large-scale measurement experiment testbed from Japan and France. Each PC is directly connected to the Internet within UPMC or the University of Tokyo network.