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Traffic analysis of peer-to-peer IPTV communities

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ABSTRACT

The Internet is currently experiencing one of the most important challenges in terms of content distribution since its first uses as a medium for content delivery: users from passive downloaders and browsers are moving towards content producers and publishers. They often distribute and retrieve multimedia contents establishing network communities. This is the case of peer-to-peer IPTV communities.

In this work we present a detailed study of P2P IPTV traffic, providing useful insights on both transport- and packet-level properties as well as on the behavior of the peers inside the network. In particular, we provide novel results on the (i) ports and protocols used; (ii) differences between signaling and video traffic; (iii) behavior of the traffic at different time scales; (iv) differences between TCP and UDP traffic; (v) traffic generated and received by peers; (vi) peers neighborhood and session duration. The knowledge gained thanks to this analysis is useful for several tasks, e.g. traffic identification, understanding the performance of different P2P IPTV technologies and the impact of such traffic on network nodes and links, and building more realistic models for simulations.[1]

1. Introduction and motivation

In recent years we are experiencing a dramatic change in how users influence the evolution of the Internet and its services. Users create events, making new content and services available; they create communities, in which active participation, user interaction, and information sharing, are highly encouraged; and demand new technologies supporting them. User demands and new forms of interaction drive the network evolution, bringing new network applications, new communication paradigms, and new network architectures. A few notable examples of this small revolution are the explosion of Internet Blogs, Video publishing and distribution systems, social networks built through the Web, Virtual Worlds, network games, etc. [1,2].

Therefore, by interacting through the network, users create new forms of communities and new forms of content distribution: we are assisting to a shift from the traditional distribution paradigm of few content providers *vs* many consumers, to a new paradigm that sees many content providers and consumers [3]. In addition, the availability of new services and forms of interaction driven by users are, at the same time, changing users' behaviors and expectations. People start to use the Internet for activities previously happening only in certain contexts and through different technologies. This is the case, for example, of peer-to-peer IP Television (P2P IPTV), and network gaming in virtual worlds. The time and place of such activities change, and services become ubiquitous. People move from the *sofa at home* to the workplace or a café to enjoy

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such services. Moreover, they interact with communities that range on a global scale rather than having a strong local geographical bound. Such new scenarios make the traditional content distribution systems partially dated, thus increasing the interest of network operators and industry in general to support new service typologies.

The popularity of Internet-based television is expected to grow during the next years for several reasons [8]. First, it is well known that in the recent past, especially for some events such as the 9/11, the Internet has been the major source of information for people at their workplace. Second, users appreciate the generalist TV always less, whereas they are more interested in specialized content on TV and in being able to interact somehow with other users or by adding content (commenting or asking questions to the community watching the same videos is one of the simplest examples) [6]. Third, in some countries the quality and the range of the offer of TV contents is scarce. Finally, as fourth, the "*Broadcast yourself*" phenomenon is constantly increasing, both with "**Tube*" sites and the creation of more elaborate TV programs with realtime broadcasting created by single users [7,4,5]. To testify such trends, several sources report on the loss of audience and of monetary income of the traditional TV industry. Therefore, the interest in understanding such new technologies to support and improve them is enormous [7].

The use of the P2P paradigm to deliver live television on the Internet (P2P IPTV) is gaining increasing attention [9], and has become a promising alternative to other legitimate approaches as the classical client–server model, content delivery networks (CDNs) [61], or IP-Multicast. Indeed, television service targets a large number of users and a simple client–server approach will not scale to a large audience because servers have limited available resources (CPU, bandwidth) that will decrease proportionally with the number of users. By multiplying the servers, CDNs only scale to a larger audience with regards to the number of deployed servers. CDNs have also a high infrastructure cost, which will partially limit its use by the content providers. Finally, the lack of deployment of IP-Multicast limits the availability and scope of this approach for a TV service on the Internet scale [62]. In P2P networks, instead, peers will contribute their resources (CPU, upload bandwidth) and are at the same time downloaders and uploaders of realtime video-streams. The available resources to deliver the content increase with the number of users and can scale to a large user population, without any additional infrastructure cost. Moreover, by using the existing Internet infrastructure as a medium and by exploiting user participation for the creation of the content distribution network, P2P IPTV technologies have innovative potentials: (i) to make any TV channel from any country globally available, (ii) to make each Internet user a content creator and distributor by broadcasting his own "TV" with trivial costs. These are some of the reasons behind the increasing popularity of such applications among Internet users. This trend is also confirmed by the amount of new P2P IPTV applications that become continuously available, and by the fact that the traffic generated by such applications has recently increased significantly.

In this paper we point our attention on the study of P2P IPTV communities. More precisely, we study the traffic generated by the four most used P2P IPTV applications at the time of the experiment, and still considered today among the top P2P IPTV applications: *PPLive*, *PPStream*, *Sopcast*, *TVants*. Analyzing four applications instead of a single one makes our analysis more complete and allows to investigate the generalizability of the observed results. One of the contexts that have brought P2P IPTV to the attention of Internet users and have also pushed new people to use the network and participate to network communities, is that of worldwide sport events. Such applications allowed people from all over the world to watch events not broadcast (or not freely broadcast) by their national TVs. For this reason, in this paper we chose to analyze the traffic generated by peers of the community watching the 2006 FIFA World Cup (June/July 2006).

The work here aims at a better understanding of the mechanisms used by such applications and their impact on the network, despite their use of proprietary unpublished protocols, by directly looking at the traffic they generate. We aim at understanding: (i) which transport-level protocols are used and what are the consequences of different choices; (ii) how traffic is divided into signaling and data, and into upload and download directions, in order to study and characterize them separately; (iii) criteria useful to discriminate between signaling and data traffic and to identify P2P IPTV traffic; (iv) statistical properties of P2P IPTV useful to understand the impact on network nodes and links (e.g. long-range dependence); (v) how peers interact, how much they contribute to the content distribution, and what is their typical lifetime; and (vi) what is the download policy of the different applications. The results presented here are relevant to identify traffic generated by such applications, to understand their impact on network nodes and links, and to build realistic simulations and emulations.

The paper is structured as follows: we describe the considered applications and the measurement setup in Section 2. Afterward, we analyze the results related to lower-level traffic characteristics in Section 3, and those related to peers behavior in Section 4. In Section 5 we overview the literature related to the measurement of P2P IPTV communities. Finally, Section 6 ends the paper with discussion and conclusion remarks.

2. Description of the experiments

With the aim to better understand both traffic properties and peer behavior of a P2P IPTV community during a worldwide event, we considered four applications. Analyzing different applications allows studying such communities without being too closely related to the design of the applications and thus making the results more general. We collected traffic traces during the 2006 FIFA World Cup from June 09 to July 09 because we believe that it can be representative of events of interest in P2P IPTV communities. The 2006 FIFA World Cup represents indeed one of the biggest worldwide sport events that attracted tens of millions of viewers from all over the world. The mobile