Network Impact of P2P-TV Zapping

Manxue Wang Olivier Fourmaux
UPMC Sorbonne Universités
4, place Jussieu,
75005 Paris, France
Email: olivier.fourmaux@upmc.fr

Yuko Nakamura Takumi Miyoshi
Shibaura Institute of Technology
307 Fukasaku, Minuma-ku, Saitama-shi,
Saitama, 337-8570 Japan
Email: miyoshi@shibaura-it.ac.jp

***Abstract*—With potentially hundreds of millions of users, P2P-TV applications plays an increasingly important role in the network communication. P2P-TV puts a great traffic pressure on Internet backbone and access networks. It is thus important to acquire an in-depth understanding of the associated peer data exchange. Most of the works already done around P2P-TV applications focus on the steady state but those applications have a highly dynamic behavior and the transient state could be very significant in the overall network impact.**

In this work, we make an analysis of the traffic characteristics when a user is starting to watching one channel. On the basis of these, we have made comparisons of the data obtained by the user zapping between multiple channels. Then we provide incite for further works.

***Index Terms*—P2P-TV, Peer to peer computing, Data network measurement, User behavior, Channel switching.**

I. Introduction

As the last step of the network convergence, the Internet offers more and more broadcast audio/video services such as TV. These multimedia services were confined to broadcast infrastructure because the transmission of quality television stream in standard or high definition requires the use of enormous resources in data networks. The development of technologies for the distribution of multimedia content is either local and limited to a residential operator (IPTV), or wide and expensive (CDN).

An alternative to these costly technologies potentially lies in the peer-to-peer approaches (P2P). These have demonstrated their ability to leverage resources in the file transfer and distributed computing. As part of the TV, specific constraints require substantial changes to the P2P. A new class of application is trying to achieve this type of services: P2P-TV. Among the most popular, we can cite SOPCast [1], PPStream [2], PPLive [3], or UUsee [4].

One of the major problems with this application is that they are proprietary and closed. Their behavior is known only after analysis of network traffic they generate. There were many analyses of these P2P-TV applications but most of these experiments only studied the underlying mechanisms or architectures used by these proprietary applications. They did not study some coupling between the behavior of the user and the measured results. For example most of the previous works focus on the steady state corresponding to a user staying the same channel for a long time. However, there is also another type of users doing channel zapping corresponding to transient state series.

In this work we take interest firstly in the P2P-TV peer behaviors, especially in the transient state (channel access or zapping). We extract from our traces how many peers are involved when users watch one channel or zap between several channels. More specifically, we try to characterize the peer arrival and departure process in this cases. For the study of the difference of the number of peers from the transient state to steady state, the traffic increase at the channel arrival and the channel zapping overhead are key parameters to understand the whole behavior of such applications.

We attempt to answer these questions by using a standard P2P-TV application and packet sniffers deployed in a high-speed campus access point. Quantitative results obtained in our study are presented.

The paper is structured as follows: We describe the considered applications and the measurement setup in section II. In section III, we introduce the performance of one channel. Then we study the performance of five channels with zapping in section IV. We present related work in section V, and then discuss issues for further work and conclusion in section VI.

II. Description of the experiments

With the aim to have a better understanding of traffic properties and of peer behavior, we focused on the most popular P2P-TV applications, namely SOPCast, PPSTream, PPlive and UUsee. These four applications mainly broadcast Chinese live-TV channels, so we tuned each application to five such channels, namely CCTV1, CCTV2, CCTV4, CCTV10 and CCTV13.

For our experiments, we performed numerous 5 to 8 minute-long experiments during four different time periods respectively, 14h-15h, 16h-17h, 17h-18h, 20h-21h[1]. We collected packet-level traces while we were watching the same set of channels. This measurement campaign took place from the end of June to the end of July 2011.

Two kinds of experiments were conducted : Firstly, we watched one channel in order to observe their specific transient states and the steady states. Secondly, we studied the case of several channels, so we set the same performing duration for each channel, and then switched over each channels

[1] All the times are given in the GTM+1 zone.

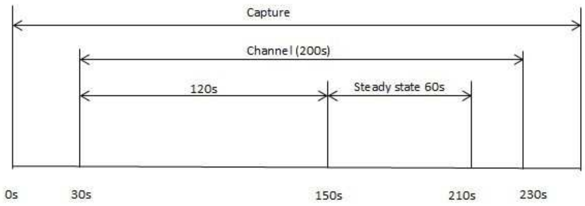

Fig. 1. Timing diagram with one channel.

sequentially. For the performing duration for each channel, we set five levels: 5s, 10s, 15s, 20s and 25s.

In this paper, we focused on very restricted set of measurement as a sample of our work : one trace for one single channel and one trace for the five channels measurement, collected with SOPCast on 30 June at 14h-16h in the campus network of the UPMC Sorbonne University. We selected these traces because the time period on that day was the peak hours in China (Chinese time 20h-22h), so there were a large number of P2P-TV users and it gave representatives results. Of course, we also analyzed the other collected traces and we obtained quite similar results to those explained here.

Other parameters that can impact our results are the followings: our nodes are running on average PCs under Windows XP operating system. They are situated in a university, and are connected to the Internet with 100Mbps Ethernet NIC through a campus network with symmetric upload and download capacity. Our primary measurement location is situated in a campus in Paris, France, with high-speed access european academic network and large peering with most major transit operators. The comparison with other measurement done in a very similar context but in different location in Tokyo, Japan [5], is not still available but must be for the conference.

III. Performance with one channel

In this section, we analyze traffic characteristics for one channel. Before proceeding our analysis, in order to better understand the experiment as well as traffic characteristics, we divide traffic activity into two different periods: from the beginning of watching a channel to steady state in traffic and the steady state itself. It is illustrated in the timing diagram of Fig. 1. First, we start the P2P-TV application, and capture packets. After 30 seconds, we select a channel to watch. Then, we maintain the channel viewing during 200 seconds: The first 120 seconds, we will assume that it include the transient state and is sufficient to reach the steady state; the next 60 seconds is to have a reference sample of the steady state. Then we leave the channel 20 second later and keep the capture running for 40 seconds. All of the observing time is then 270 seconds.

We focus on one trace showing the access of one channel (CCTV1) with SOPCast P2P-TV application. We show here some general traffic properties such as their sizes, dynamics of peers, download and upload traffic and then we discuss some issues related to the separation of video and signaling flows to check our results.

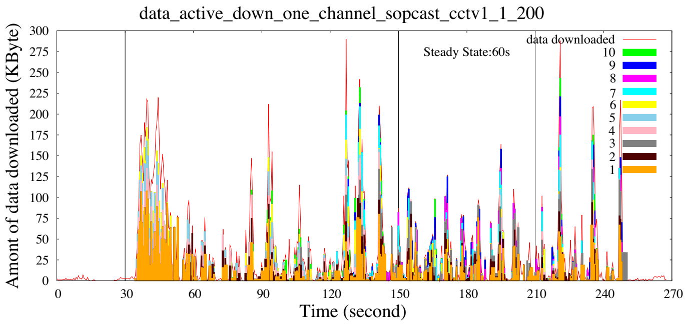

Fig. 3. Data downloaded with one SOPCast channel.

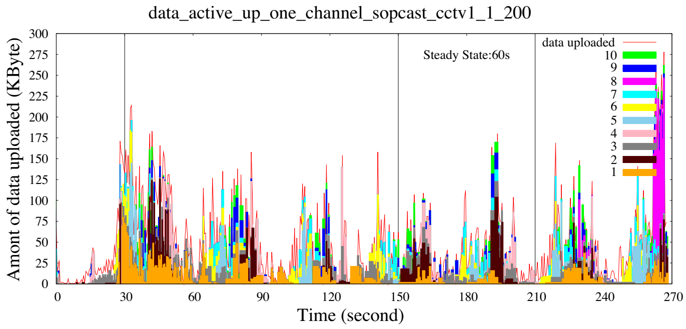

Fig. 4. Data uploaded with one SOPCast channel.

Firstly, we look at the number of peers in Fig. 2. We consider that for one channel, the total number of peers varies between 50 and 70. During the full duration, the local host continually changes its partners (i.e. remote peers). This is illustrated in Fig. 2 in which the instantaneous number of peers is sampled every 0.5 second. During each time slot, some peers leave and some others arrive in the session. Compared with the total number of peers, the average number of the peers is approximately equal to 30% of the total peers. In comparison with the graphics of steady state (60 seconds) and the full trace, they are almost the same.

Secondly, in order to understand the download and upload policies, we plot the total traffic and the aggregated traffic from the top-ten peers in download (from the peers, Fig. 3) and upload (to the peers, Fig. 4). Each point of the figure represents a 0.5 second interval. For downloading, the top-ten peers contribute to almost all the traffic in full duration. It is different from the download policies in [6]. There is no top-ten peer which is concentrated at the steady state moment for the large amount of data transfer. In addition, we remark that the top-ten download peers and the top-ten upload peers have no intersection. This testifies that peers did not reciprocate fairly when downloading the traffic.

Thirdly, TABLE I contains the information regarding to the size of traces. We judge that there is much more traffic in the upload direction. This is because our nodes is situated in a university, and it is connected to the Internet with 100Mbps Ethernet NIC through a high-speed campus network. Therefore we have symmetric upload and download capacity. Moreover,

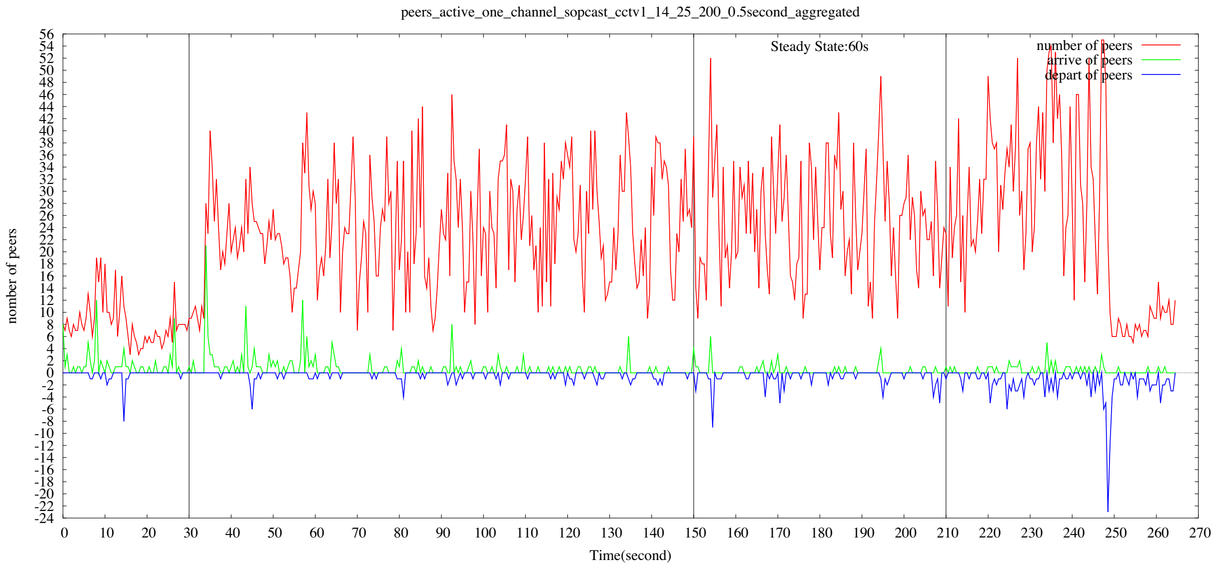

Fig. 2. Active peers associated with one SOPCast channel.

TABLE I
STATISTICAL RESULTS WITH ONE SOPCAST CHANNEL.

Trace	Total data	Duration	Download	Upload
Full	41894 KB	238s	18215 KB	22697 KB
60s	8073 KB	60s	4042 KB	3841 KB

Trace	DOWNLOAD			UPLOAD		
	Sig.(KB)	Vid.(KB)	%	Sig.(KB)	Vid/(KB)	%
Full	2165	16049	12	15216	7481	49
60s	419	3623	10	2632	1209	46

Trace	Download average BW	Upload average BW
Full	612Kbps	762Kbps
60s	539 Kbps	512Kbps

we also note that during 60 seconds of the steady state, the collected data is about 20% of the full trace data. The amount of downloaded data of the steady state is also about 20% of the full trace.

Fourthly, the P2P-TV applications generate two kinds of traffic: video and signaling. In order to separate it, we use the packet size heuristic proposed in the [6]. From this paper, we took the very simple heuristic. For each session, we count the size of packets. If the size is larger than or equal to 1200 Bytes, then it is labeled as a video session. All the non-video sessions are supposed to carry signaling information. This heuristic is very simple to implement, but it is flawed. We will mention in detail later (Section VI). Acceptably, we use this heuristic to estimate the fraction of downstream and upstream signaling overhead for the SOPCast. From the table, it is notable that the downstream signaling overhead is near 10% . Meanwhile, the upstream signaling overhead is very high, even reaching 50%.

Finally, we focus on the smooth playback problem. In [1], the bit-rate of the five live-TVs are 520 Kbps. Through the table we see that the downloaded average bandwidth is usually above 600 Kbps, even with bad playback because of transient period. For the steady state, the downloaded average bandwidth is lower than the full trace; it is near 540 Kbps and is fine for smooth playback.

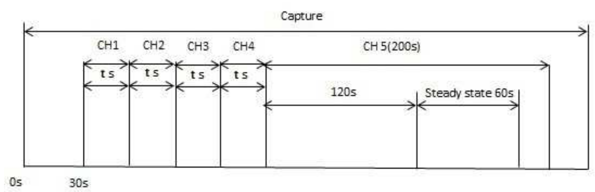

Fig. 5. Timing diagram with 5 channels.

IV. PERFORMANCE WITH FIVE CHANNELS

With zapping behavior, we can demonstrate that users could impact the network with a significant overhead.

We still use a timing diagram to describe our experiments (Fig. 5). The experiment for the 5 channels is similar to series of experiments with one channels, just joining and leaving successively 4 channels and remaining on the last one. For the first four channels, we fixed the viewing time of t seconds, at the end of t time, we immediately switch to the next channel. For the last channel, as usual, viewing time is also 200 seconds (Channel is abbreviated to CH).

We studied different zapping time and show here the results relative to t=25s. The following table shows the total amount of peers during the capture and the separated amounts relative to the channels:

Full	CH 1	CH 2	CH 3	CH 4	CH 5
601	74	48	50	50	228

From the Fig. 6, we can see that the number of new peers

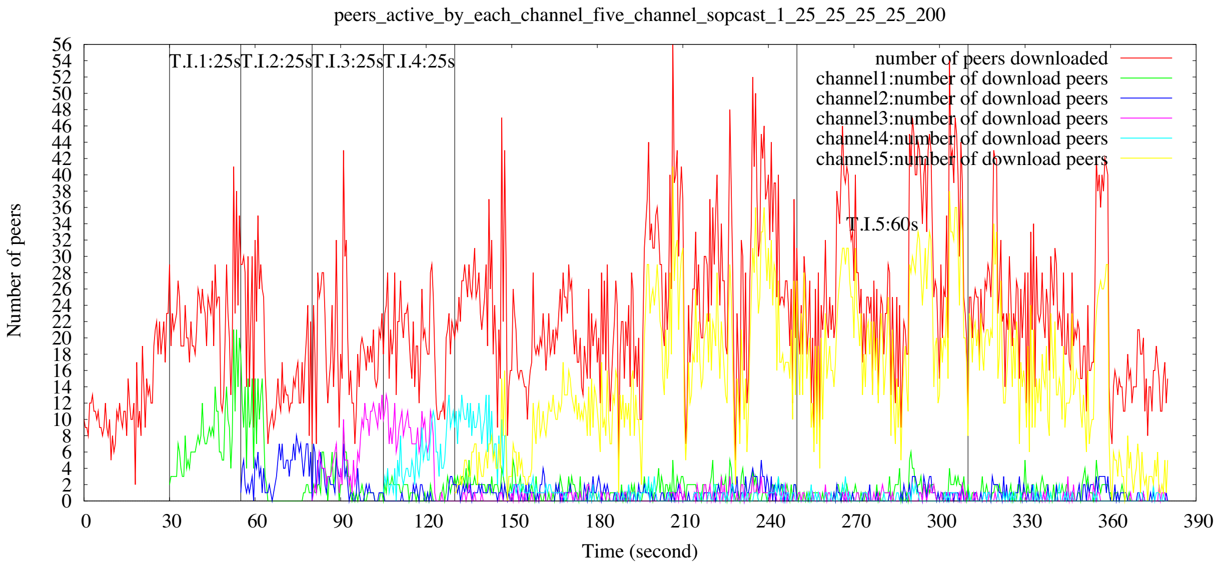

Fig. 6. Active peer per channel with SOPCast zapping among 5 channels.

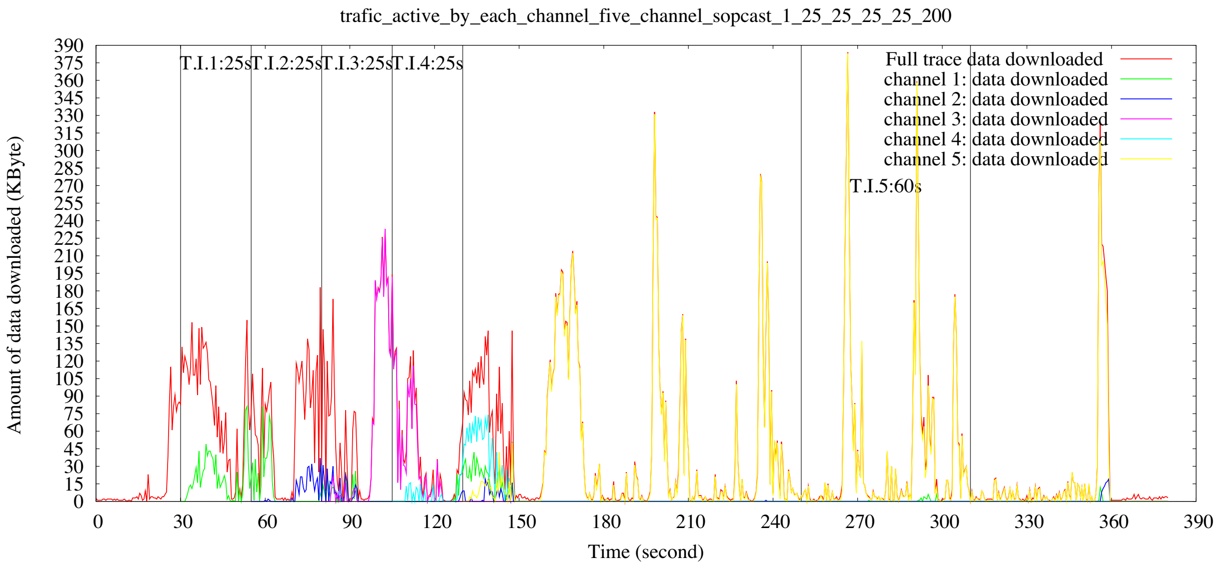

Fig. 7. Traffic per channel with SOPCast zapping among 5 channels.

increases at each zapping and remains for some time, adding some more overhead to the join procedure (the red curve shows the instantaneous number of all peers and all other colors show the new peer arriving during each channel choice). Fig. 7 shows the traffic impact of zapping with a similar representation.

Now we observe the situation of the traffic with TABLE II. Although the traffic of the first four channels has improved, not many of them are valid data. CH1 has 38%, CH2 has 37.6%, CH3 has 59%, and CH4 has 11.8%. Moreover, we can see that CH5 has been more serious impact. In its starting 25 seconds, the useless data is in majority, which directly led that the first peak of CH5 was delayed 25 seconds. Moreover, the traffic of CH5 is unstable, and the peak is always thin and small. The total traffic of CH5 fell from 77.3% to 48.8%. From this we can conclude that frequent switching channels bring much more overload.

V. Related Work

The technology of the P2P-TV is constantly updated. The trend of the research of the P2P-TV system is more and more refined. Here we did not provide an exhaustive bibliography but focus on references that directly concern our work.

In [7], it only focuses on a single P2P-TV system: PPlive for a detailed study. In particular, the authors provided useful insights on the user behaviors, the user geographic distribution, the playback delay and playback lags among peers, and the characteristics of the connection and traffic. This article made two contributions on the research of the P2P-TV system. One

TABLE II
STATISTICAL RESULTS WITH FIVE SOPCAST CHANNELS.

Trace	T.D.D(KB)	T.I.1(25s)	%	T.I.2(25s)	%	T.I.3(25s)	%	T.I.4(25s)	%	T.I.5(60s)	%
Full	32290.0	4069.0	12.6	3146.0	9.7	3866.0	12.0	2073.0	6.4	4819.0	14.9
CH 1	2628.0	999.0	38.0	531.0	20.2	219.0	8.3	81.0	3.1	40.0	1.5
CH 2	898.0	0.0	0.0	338.0	37.6	265.0	29.5	12.0	1.3	3.0	0.3
CH 3	4153.0	0.0	0.0	0.0	0.0	2450.0	59.0	1689.0	40.7	3.0	0.1
CH 4	1775.0	0.0	0.0	0.0	0.0	0.0	0.0	210.0	11.8	2.0	0.1
CH 5	15752.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4651.0	29.5

is providing a heuristic to distinct the signal and the data from the trace. The other is that the authors concluded that the P2P-TV users have the similar viewing behaviors to regular TV users. In [8] a detailed study of the IPTV system and user behavior shows the interest in studying zapping.

Then the research of the P2P-TV began to focus on the comparison of several different P2P-TV applications. In [6], the authors focused on studying the traffic generated by the four most used P2P-TV applications: PPLive, PPStream, SOPCast, and TVants. The authors provide results on the (i) ports and protocols used; (ii) differences between signaling and video traffic; (iii) behavior of the traffic at different timescales; (iv) differences between TCP and UDP traffic; (v) traffic generated and received by peers; (vi) peers neighborhood and session duration.

The article [9] shows much wider comparisons. It analyzed almost all type of Internet P2P applications and focused on the passive measurement approach used in our work.

The article [10] aims at assessing the level of network awareness embedded in the applications, i.e., the metric of peer selection. They defined a framework for directly and compactly comparing different network properties and P2P systems.

Moreover, the article [11] focused on the level of collaboration between peers, their location and the effect of the traffic on the networks. By analyzing four popular P2P-TV applications, namely PPStream, TVUPlayer, SOPCast, and TVants, from multiple points located in France and Japan, the authors found that the P2P-TV application lacks two mechanisms: a locality-aware mechanism and a new incentive mechanism which are utilized to force peers to collaborate in the network.

Our work also belongs to the range of analysis the impact to the network. However we are more focused on the behavior of users, such as frequent switching channels.

VI. SUMMARY AND OUTLOOK

This paper presented a preliminary work on a quite understudied user behavior in P2P-TV systems: the transient periods and especially during channel zapping. We suspect a strong impact on the network during this phases when we observed high overhead. If we add this to adverse network condition, we can easily predict a serious network impact. This point is very significant in a context of ISP traffic differentiation where the operator should know potential drawback when they could initiate such applications.

In this document we presented a sample of all the traces we collected in France. We have already had wider results concerning local overhead, but we also want to generalize our work with other results we have previously made and presented in [5]. Our goal is to correlate this with other measurement made in Japan to be able to generalize our results the same way as in [11]. It would be done in the next month and should be available for the poster session of WTC 2012.

Another way we also investigate is to try to set up adverse network condition on such P2P-TV systems to produce similar environment to those of ISP trying to control P2P traffic and we expect to prove the negative impact of such network neutrality infraction.

REFERENCES

[1] SOPCast. [Online]. Available: http://www.sopcast.com.

[2] PPSTream. [Online]. Available: http://www.ppstream.com.

[3] PPLive. [Online]. Available: http://www.pplive.com

[4] UUSee. [Online]. Available: http://www.uusee.com

[5] Y. Nakamura, T. Miyoshi, and O. Fourmaux, "Traffic analysis considering channel zapping on p2p video delivery service," IEICE, Tech. Rep. CQ2011-27, July 2011.

[6] T. Silverston, O. Fourmaux, K. Salamatian, A. Dainotti, A. Botta, A. Pescape, and G. Ventré, "Traffic analysis of peer-to-peer IPTV communities," *Elsevier Computer Networks*, vol. 53, no. 4, pp. 470–484, March 2009. [Online]. Available: http://dx.doi.org/10.1016/j.comnet.2008.09.024

[7] X. Hei, C. Liang, J. Liang, Y. Liu, and K. Ross, "A measurement study of a large-scale p2p iptv system," *IEEE Transactions on Multimedia*, vol. 9, no. 8, pp. 1672–1687, December 2007.

[8] M. Cha, P. Rodriguez, J. Crowcroft, S. Moon, and X. Amatriain, "Watching television over an ip network," in *ACM/USENIX IMC'08*, Athens, October 2008.

[9] D. Rossi, E. Sottile, and P. Veglia, "Black-box analysis of internet p2p applications, peer-to-peer networking and applications," 2010.

[10] A. Horvath, M. Telek, D. Rossi, P. Veglia, D. Ciullo, M. A. Garcia, E. Leonardi, and M. Mellia, "Network awareness of p2p live streaming applications," in *HOTP2P Workshop at IEEE IPDPS'09*, Rome, May 2009.

[11] T. Silverston, O. Fourmaux, K. Salamatian, and K. Cho, "On fairness and locality in p2p-tv through large-scale measurement experiment," in *IEEE Globecom'10*, December 2010.