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Integrated Measurement and Analysis of P2P Streaming Traffic by the Java Tool Atheris

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I. INTRODUCTION

Currently, the rapid development of new multimedia services including VoIP, video streaming and video on demand as well as IPTV and the integration of triple play into the service portfolios of ISPs and network operators indicate an evolutionary path towards next generation networking. *Peer-to-peer (P2P) overlay networks* are used with growing intensity to implement the content dissemination and control planes of many new portals and their multimedia service components like GoalBit, Zattoo, PPLive, SopCast, Vodder or Skype. However, despite intensive measurement campaigns (cf. [3], [4] among others), publicly available integrated systems to monitor streaming traffic in such networks and to analyze its features are rarely provided yet. The presented JAVA tool Atheris constitutes an approach to overcome this deficiency.

II. RESEARCH OBJECTIVES

To respond to the rapid deployment of P2P overlay structures, we have developed a comprehensive *P2P traffic analysis concept* (cf. [1], [2]). It integrates four orthogonal dimensions to cope with the analysis of P2P structures and P2P traffic characterization, namely: (1) single site traffic measurements at the packet level combining passive and active monitoring techniques, (2) data extraction, analysis and inspection of P2P overlays based on a hierarchical multi-layer modeling concept, (3) a characterization of overlay structures by techniques and metrics of complex networks, (4) a statistical characterization of P2P traffic features using the analysis and estimation of the bivariate distributions $\mathbb{P}\{X_i \leq x, Y_i \leq y\}$ of packet inter-arrival times X_i and packet lengths Y_i extracted from corresponding flow data $\{(X_1, Y_1), \dots, (X_n, Y_n)\}$ of collected i.i.d samples.

III. HIERARCHICAL MULTI-LAYER MODELING OF P2P OVERLAY NETWORKS

Inspired by Tang et al. [5], we have applied a hierarchical multi-layer modeling approach to perform the analysis of a P2P structure, the traffic characterization, and the interactive investigation of corresponding traffic flows of P2P sessions and to evaluate the network awareness of P2P applications. It covers both the observable parts of the overlay structure by an undirected *neighborhood graph* $G_N = (V_N, E_N)$

among an object specific, time dependent finite peer population $\mathcal{P}^{(O_i)}(t) = \{p_1(t), \dots, p_{n(t)}(t)\} \subset \mathcal{U}$ and a directed *dissemination flow graph* $G_V = (V_V, E_V, f, c)$, $V_V \subseteq V_N$, among pairs (p_i, p_j) of peers exchanging multimedia content as well as the underlying TCP/UDP-IP transport network connecting the peers p_i by flow paths p along capacity constrained links (e_k, c_k) (see Fig. 1).

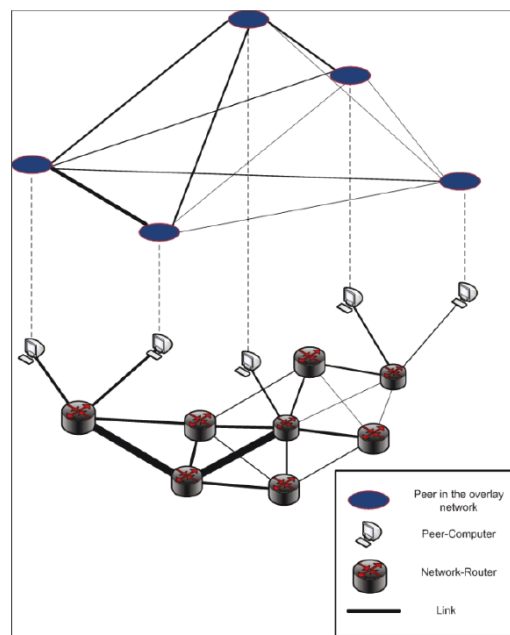


Fig. 1. Hierarchical modeling of P2P overlays.

IV. ARCHITECTURE OF THE JAVA TOOL ATHERIS

Following a modular object-oriented software design, the concept has been used to develop the new versatile, extensible *JAVA measurement and analysis tool Atheris*. The latter has been implemented both for a Linux and Windows OS. The Linux version is built on top of libpcap and its Java wrapper Jpcap and integrates an adjusted C version of a bandwidth estimation tool. The Windows version relies on WinPcap, Jpcap, and a Java based implementation of the bandwidth estimation system (see Fig. 2).

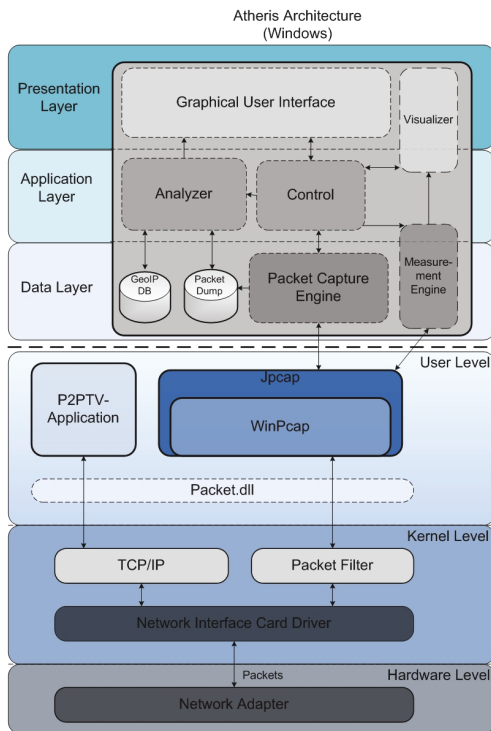


Fig. 2. Design of Atheris.

V. CHARACTERIZATION OF TRANSPORT PATHS AND TRAFFIC FLOWS OF PEER-TO-PEER SESSIONS

The major advantage of Atheris arises from the possibility to simultaneously monitor and analyze in an on-line manner P2P applications as well as to probe actively the connections $\{p_i, p_j\} \in E_N$ and, thus, the underlying dissemination route p to a home peer p_i . For this purpose trace-routing is applied at the IP layer of the transport paths p (see Fig. 3). One key analysis feature concerns the capability to estimate the available bandwidth $c = \min\{c_i \mid e_i \in p\}$ of specific paths p from (or to) p_i along its directed links $e_i \in p$ and to inspect interactively selected traffic flows $f(p_i, p_j, t)$ of certain types t related to control functions or content streams. Further capabilities allow the investigation of flows within peer-to-peer sessions by adequate inspection techniques using empirical statistical characteristics such as histograms or correlation diagrams (see Fig. 4, cf. [1]).

VI. CONCLUSIONS

We are convinced that an integrated on-line P2P monitoring and analysis system like the demonstrated JAVA tool Atheris can provide a deeper insight into the dynamics of new P2P based multimedia applications, reveal weaknesses of a P2P overlay system and support the fast development of appropriate teletraffic models of the exchanged control and content flows, both with regard to the packet and session levels as well as the structural level of the overlay (cf. [1], [2]).

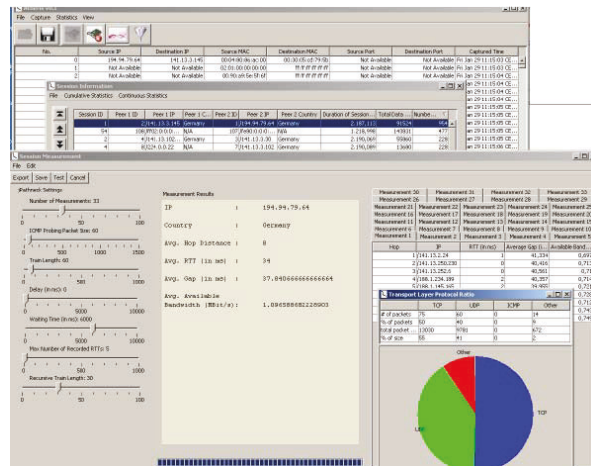


Fig. 3. Path probing by Atheris.



Fig. 4. Visualization of the estimated bandwidth of paths p .

An on-line demonstration of the tool Atheris will be presented during the demo session. It is intended to provide a public domain version of the stable JAVA system Atheris.

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