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Energy-Efficient Mobile P2P Video Streaming

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***Abstract*—The proliferation of wireless broadband technologies and mobile devices has led to an increase in mobile traffic, especially due to a rapid growth of real-time entertainment such as video streaming on smartphones. Mobile peer-to-peer-based content distribution schemes can help to relieve infrastructure-based mobile networks, but require participating nodes to provide resources which can drain their battery. Thus, the goal is to exploit mobile peers' resources while minimizing and balancing the energy consumption over all participating devices. Simulation models considering energy consumption lack precision, because they abstract away important parts of the hardware. On the other hand, prototypical energy measurements are more precise, but require a time consuming implementation and assessment. To this end, this demo paper presents a mobile P2P video streaming and benchmarking platform which enables to assess and compare the energy consumption of different approaches in a precise manner through live assessments at runtime. The demonstrated platform includes a simple, yet high-performance tree-based mobile P2P streaming overlay which can be utilized to easily implement and assess further streaming overlay approaches.**

I. Introduction

Along with the appearance of a steadily growing number of mobile devices comes an increase in mobile video traffic. Recent studies report real-time entertainment traffic to account for more than 50 % of mobile traffic in the U.S. and project a further rapid growth [1]. In order to relieve mobile infrastructures from this burden, the integration of WiFi-based mobile peer-to-peer (P2P) networks with cellular communication networks is an appealing idea [2], [3]. To do so, peers who receive a video stream over the cellular network forward it over WiFi to other recipients in their vicinity.

However, while mobile offloading schemes relieve cellular infrastructures, they require the active participation of nodes in forwarding traffic. Due to scarce energy resources of mobile devices, an energy efficient streaming is the key, as the battery capacities limit the life time of the network. Therefore, it is crucial to take energy consumption into consideration when designing new mobile streaming approaches. However, assessing the energy consumption of mobile devices in a precise manner is a challenging task. Simulation models lack precision since they consider the energy consumption of sending and receiving data only, while abstracting from other hardware components, and can thus only deliver approximations. In order to get a precise view on the network's overall energy consumption, real measurements based on a time intense prototypical implementation are needed.

To this end, the contribution presented in this demo paper includes an Android-based mobile P2P streaming and benchmarking platform, which can be used to do a fast, prototypical implementation and assessment of mobile P2P streaming overlays. The platform allows to study the energy consumption during runtime, and thus enables the comparison of different P2P streaming approaches regarding their energy-efficiency in a precise manner. The source code of the platform has been published[1], to enable the community to benchmark other P2P streaming overlays on Android-based mobile devices.

II. Mobile P2P Streaming Architecture

The mobile P2P streaming architecture is depicted in Figure 1. Due to the utilization of standardized protocols and interfaces to communicate with Android specific components, the architecture can be ported to other systems as well.

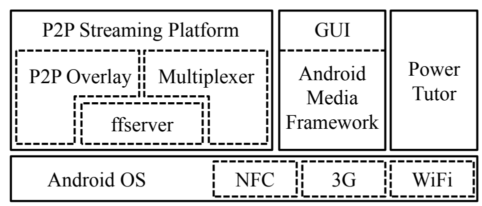

Fig. 1. Basic Architecture of the Mobile P2P Streaming Platform

The key entity of the P2P streaming platform is the P2P overlay component, which provides the signaling part related to the P2P streaming overlay. It can be easily exchanged with alternative overlay implementations (*e.g.*, mesh/pull based) by researchers and developers. The P2P overlay component is complemented by the multiplexer, which deals with the actual video stream. The multiplexer supports the Real-Time Transport Protocol (RTP)/Real-Time Transport Control Protocol (RTCP). It can be configured by the P2P overlay component to forward packets to a number of peers and to the local Android Media Framework, that displays the stream on the Graphical User Interface (GUI). As RTP/RTCP is utilized for the transmission of the stream as well as for local playback, the Android Media Framework copes with packet loss by skipping missing packets and sorts wrongly ordered packets automatically, which greatly simplifies custom development.

Testing a streaming prototype is simplified by two features: First, a possibility is provided to stream locally stored video files using a stripped down and adapted ffserver [4] library, which is encapsulated using the Java Native Interface (JNI) framework. Additionally, a means to initiate join operations to the P2P overlay is provided using Near Field Communication

[1] http://www.ps.tu-darmstadt.de/research/smartnets/

(NFC): the devices are held back-to-back to exchange the necessary information for bootstrapping a new peer.

III. Energy Benchmarking Platform

The energy benchmarking platform is used for optimization of a new P2P streaming overlay during the development cycle. It allows for the assessment of the consumed energy in the network by aggregating and visualizing samples of the participating devices in real-time. The basic architecture of the platform and its intended use within a development environment is depicted in Figure 2.

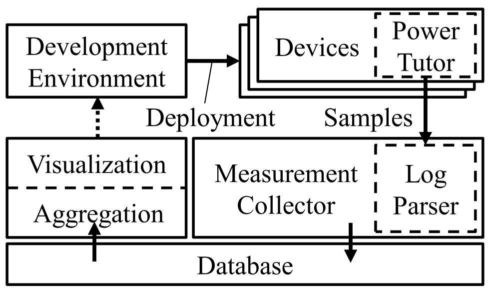

Fig. 2. Basic Architecture of the Energy Benchmarking Platform

For sampling the energy consumption on the devices, the PowerTutor implementation [6] of the PowerBooter energy model [5] has been applied. The model estimates energy consumption from a set of parameters, that are accessible on-device (*e.g.* CPU utilization and current frequency, WiFi utilization, and hardware states) and was shown to be an accurate solution to assess the energy consumption of mobile devices. The results are application specific, which allows to measure the energy consumption of the streaming platform in an isolated manner.

The PowerTutor implementation is used locally on the devices. It was modified to send energy samples to a measurement collector at a rate of 1.2 kB/s, which is negligible compared to the transmitted video data. The measured samples and additional information like hardware states and process lists are parsed by a log parser and stored in a relational database. The results are aggregated as well as filtered for statistical outliers, smoothed, and visualized in a diagram. A web frontend enables to access the measured data and allows to select single nodes, subsets of nodes, or an entire network to be monitored.

IV. Demonstration Scenario

The demonstration scenario is composed of three Google Nexus S smartphones and a laptop which collects and visualizes energy measurements and serves as the development environment. All devices are connected to a WiFi access point embedded in the source peer providing the video stream. A simple, yet high-performance P2P streaming overlay component was implemented, which maintains a tree-based overlay topology with additional fallback connections to a node's grandparent. The P2P overlay also handles peer joins, peer leaves, and provides a simple load balancing scheme.

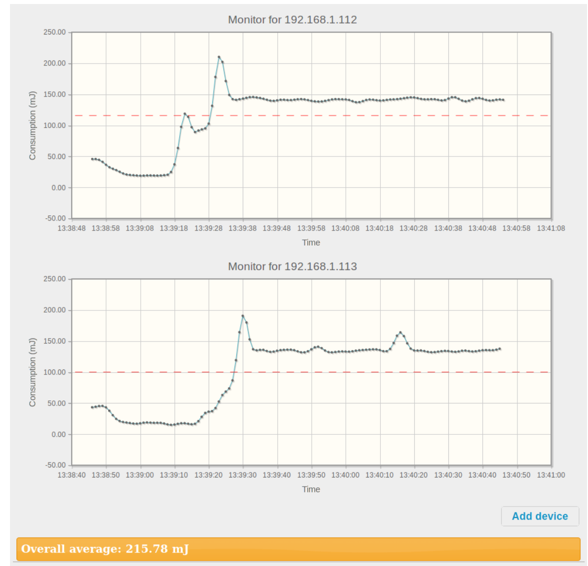

Fig. 3. Screenshot of the Energy Benchmarking Platform

The capabilities of the P2P streaming platform are demonstrated by turning nodes into mobile streaming sources, while join and leave operations are performed using the NFC feature. In parallel, the energy consumption of the participating nodes is monitored and the effects of overlay parameter variations on the energy consumption are demonstrated. A screenshot of the benchmarking platform's web frontend is shown in Figure 3. The pair of diagrams shows the measured energy consumption of a streaming overlay with two nodes. The peaks mark the begin of the streaming process, while the upper graph (streaming source) shows a slightly higher average energy consumption in comparison to the lower streaming peer.

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References

[1] Sandvine: Spring 2012 Global Internet Phenomena Report. Available at http://www.sandvine.com/news/global_broadband_trends.asp. Last access June 2012.

[2] D. Cavalcanti, et al.: Issues in Integrating Cellular Networks WLANs, and MANETs: A Futuristic Heterogeneous Wireless Network. IEEE Wireless Communications, 12(3), pp. 30-41, June 2005.

[3] K. Lee, et al.: Mobile Data Offloading: How Much Can WiFi Deliver? ACM CoNEXT, pp. 425-426, Dec 2010.

[4] Ffserver Documentation. Available at http://ffmpeg.org/ffserver.html, Last access June 2012.

[5] L. Zhang, et al.: Accurate Online Power Estimation and Automatic Battery Behavior Based Power Model Generation for Smartphones. ACM/IEEE/IFIP CODES+ISSS, pp. 105-114, Oct 2010.

[6] PowerTutor: A Power Monitor for Android-Based Mobile Platforms. Available at http://powertutor.org/. Last access June 2012.