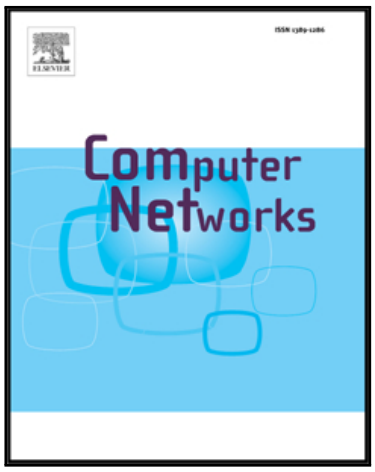

Characterizing the Behavior of Handheld Devices and Its Implications

Xuetao Wei, Nicholas C. Valler, Harsha V. Madhyastha,
Iulian Neamtiu, Michalis Faloutsos

PII: S1389-1286(17)30003-8
DOI: 10.1016/j.comnet.2017.01.003
Reference: COMPNW 6085

To appear in: *Computer Networks*

Received date: 3 February 2016
Revised date: 21 December 2016
Accepted date: 3 January 2017

Please cite this article as: Xuetao Wei, Nicholas C. Valler, Harsha V. Madhyastha, Iulian Neamtiu, Michalis Faloutsos, Characterizing the Behavior of Handheld Devices and Its Implications, *Computer Networks* (2017), doi: 10.1016/j.comnet.2017.01.003

Characterizing the Behavior of Handheld Devices and Its Implications

Xuetao Wei[a,*], Nicholas C. Valler[b], Harsha V. Madhyastha[c], Iulian Neamtiu[d], Michalis Faloutsos[e]

[a] *University of Cincinnati*
[b] *Crowdcompass, Inc.*
[c] *University of Michigan*
[d] *New Jersey Institute of Technology*
[e] *University of California, Riverside*

Abstract

The Bring-Your-Own-Handheld-device (BYOH) phenomenon continues to make inroads as more people bring their own handheld devices to work or school. While convenient to device owners, this trend presents novel management challenges to network administrators as they have no control over these devices and no solid understanding of the behavior of these emerging devices. In order to cope with the impact of these BYOHs on current existing network management infrastructures, we identify two tightly-coupled questions that network administrators need to answer: (a) how do these BYOHs behave? and (b) how can we manage them more effectively based on the understanding of their behaviors? In response, we design and deploy Brofiler, a framework that could enable network administrators to effectively manage BYOHs via behavior-aware profiling. Our behavior-aware profiling captures the behaviors of each individual BYOH and improves the visibility on managing these BYOHs. In detail, the contributions of our work are three-fold. First, we present Brofiler, a time-aware device-centric approach for grouping devices into intuitive behavioral groups from multiple perspectives, including data plane, temporal behavior, and the protocol and control plane. Second, we conduct an extensive study of BYOHs using our approach with real data collected over a year, and highlight several novel insights on the behavior of BYOHs. For example, we find that 70% of the BYOHs generate 50% of their monthly data traffic in one day, while remaining mostly idle the rest of the month. In addition, 68% of BYOHs do not conform to DHCP protocol specifications. Third, we present the implications of our study based on the framework in DHCP management, bandwidth management and access control. Overall, our approach could enable network administrators better understand and manage these new emerging devices for their networks in the post-PC era.

Keywords: Handheld devices, behavior, measurement, management.

1. Introduction

In the post-PC era, smartphones and tablets are becoming ubiquitous in companies and universities. These devices are used more and more to complement, or even replace, desktops and laptops for computational needs: Gartner market research indicates that worldwide PC shipments decline while smartphone sales grew rapidly [1]; hence the *Bring Your Own Handheld-device* (BYOH) practice is going to increase. However, though the emergence of these devices changes the society rapidly, current network management infrastructures evolve slowly to accommodate them, which creates the challenges for the network administrator to effectively manage these devices in their networks. We use the term BYOH to describe only smartphones and tablets, in accordance with the National Institute of Standards and Technology's definition [2]. In other words, we consider a device as BYOH if it runs a mobile OS, such as Android, iOS, or BlackBerry OS.

We argue that BYOHs deserve to be studied as a new breed of devices as the loss of visibility into BYOHs brings the challenges to network administrators and add another layer of complexity on network management [3]. In detail, first, every time a new technology or a new killer app emerges, IT departments must re-evaluate the way they manage their networks. Network administrators must understand the behavior of BYOHs in order to manage them effectively. Second,

*Corresponding author
Email address: weix2@ucmail.uc.edu (Xuetao Wei)