Chapter 14
Measuring the Deployment of Internet Protocols

Tapio Levä
Telia Company, Finland

Antti Riikonen
Verto Analytics Inc., Finland

Juuso Töyli
Aalto University, Finland & University of Turku, Finland

Heikki Hämmäinen
Aalto University, Finland

ABSTRACT

Internet protocols and traffic are the foundation of the internet and reflect the on-going digital transformation in the society. Internet protocols spread to potential adopters through several successive phases of implementation, commercialization, acquisition, and adoption. This protocol deployment process involves several stakeholders and varies depending on the deployment environment and the protocol in question. This complexity and the lack of comprehensive measurement studies call for a further conceptualization of measuring protocol diffusion along the whole deployment process. Therefore, this chapter develops a framework for measuring the deployment of internet protocols, consisting of deployment steps, deployment models, deployment measures, and data sources. The illustrative results indicate that protocol deployment is driven by applications, and show the existence of large deployment gaps between the protocol possession and usage.

INTRODUCTION

The Internet constitutes a unique environment for innovation diffusion due to its global, distributed and loosely regulated nature where control over resources is spread among a multitude of stakeholders with diverse economic goals (Marcus, 2004). The Internet Engineering Task Force (IETF) develops and standardizes Internet protocols as voluntary standards. Diffusion of Internet protocols is a relevant

DOI: 10.4018/978-1-5225-5320-5.ch014

and special example of standards diffusion because the IETF operates a bottom-up marketplace for individual protocol standards. Moreover, the Internet protocols are networked innovations, which exhibit significant network externalities (Katz & Shapiro, 1986). As a result, the diffusion of Internet protocols is a market-based process where the successful alignment of stakeholders' incentives is a key to success (Clark, Wroclawski, Sollins, & Braden, 2005).

A protocol is a software component or feature, which enables applications and services (Jorstad, Dustdar, & Do, 2005). Protocols typically spread to the end users embedded in products, such as applications, operating systems (OS), or devices – thus, diminishing the direct impact of a protocol on the end users' adoption decision (Warma, Levä, Tripp, Ford, & Kostopoulos, 2011) and increasing the impact of supply-side decisions to include the protocol in products (Kivi, Smura, & Töyli, 2012). This is an example of market-pull vs. technology-push (Ende & Dolfsma, 2005). In case of a strong technology-push strategy, a protocol can be acquired by a large population as part of a product bundle, but is possibly only used by few users. Such phenomenon, related to the gap between different adoption events, was introduced by Fichman and Kemerer (1999). On the other hand, protocols and other software features may not even become available to the potential end users due to the decisions of software and hardware vendors (Levä, Komu, Keränen, & Luukkainen, 2013), hindering the diffusion. For example, the decision of Apple not to support Flash in their mobile devices prevented end users from adopting (services based on) it.

Despite the important role of technology providers, the traditional diffusion of innovation theories (Rogers, 2003) and the case studies on protocol diffusion (e.g., Hovav, Patnayakuni, & Schuff, 2004; Ozment & Schechter, 2006; Joseph, Shetty, Chuang, & Stoica, 2007) often limit to modeling and measuring the end user adoption. As Lyytinen and Damsgaard (2001) conclude, this is insufficient for explaining the diffusion of complex, networked technologies, and the focus needs to be widened to cover the critical process features and all key players. In order to overcome too narrow perspective when analyzing the protocols' feasibility, which affects their diffusion, Levä and Suomi (2013) define *protocol deployment as a process, during which a protocol is advanced from the first specification into actual use on the Internet through steps such as implementation, commercialization, acquisition, and adoption of the protocol*. Measuring and analyzing the diffusion during all these steps is essential for understanding the deployment dynamics and identifying the critical success factors of Internet protocols.

Motivated by the special characteristics of Internet protocols and the lack of comprehensive measurement studies on protocol deployment, this chapter develops a framework for measuring the deployment of Internet protocols during the different steps. This is achieved by identifying the deployment models, measures, and data sources of each step. In addition to measuring the deployment levels that are directly linked to the steps, also deployment gaps and delays between these steps are defined and described. The developed framework is then applied to analyze the deployment of 11 protocols in the Finnish mobile market using an extensive longitudinal and cross-sectional data collected from 2003-2012.

The framework builds on the existing literature and the authors' cumulated knowledge on protocol deployment and previous data collection efforts on mobile device diffusion and usage. The data collection for the application of the framework is based on long cooperation with several industry partners and experiences from analyzing the collected datasets. The development of the framework was an iterative process, where the framework was refined based on the data analysis of the case Finland, and vice versa.

The chapter makes a methodological contribution by identifying alternative deployment models of Internet protocols and developing a framework for measuring the deployment. The chapter makes a practical contribution by applying the developed framework to an example market, and analyzing the