

Chapter 38

A Framework for Measuring the Deployment of Internet Protocols

Tapio Levä
Aalto University, Finland

Juuso Töyli
Turku School of Economics, Finland

Antti Riikonen
Aalto University, Finland

Heikki Hämmäinen
Aalto University, Finland

ABSTRACT

Internet protocols spread to potential adopters through several successive phases of implementation, commercialization, acquisition, and adoption of the protocol. This process of protocol deployment 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 article develops a framework for measuring the deployment of Internet protocols, consisting of deployment steps, deployment models, deployment measures, and data sources. The measures are further linked to each other through deployment gaps and delays. In order to demonstrate the framework, it is used to assess how a set of pre-installed protocols spread in the Finnish mobile market. The framework highlights the differences between the deployment models and the importance to use both the deployment measures and gaps in the analysis of protocol success. Furthermore, 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. The results are relevant especially to researchers interested in holistically analyzing protocol deployment and protocol developers for measuring and improving the success of their protocols.

INTRODUCTION

The Internet Engineering Task Force (IETF) develops and standardizes Internet protocols as voluntary standards. Diffusion of Internet protocols is a relevant and special example of standards

diffusion because the IETF operates a bottom-up marketplace for individual protocol standards. 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

DOI: 10.4018/978-1-4666-8111-8.ch038

stakeholders with diverse economic goals (Marcus, 2004). 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 can be understood as 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 protocol diffusion. For example, the decision of Apple not to support Flash in their mobile devices prevents 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 therefore 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 dynamics of protocol deployment and identifying the critical factors affecting the success of Internet protocols.

Motivated by the special characteristics of Internet protocols and the lack of comprehensive measurement studies on protocol deployment, this article develops a framework for measuring the deployment of Internet protocols during the different steps of protocol deployment. 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 different steps, also deployment gaps and delays between the steps are defined and described. The developed framework is then applied to analyze the deployment of 11 protocols in the Finnish mobile market by studying how they have gradually spread into mobile handset models on sale, handsets in use, and actual usage by end users, using an extensive longitudinal and cross-sectional data collected from 2003 to 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.

25 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

www.igi-global.com/chapter/a-framework-for-measuring-the-deployment-of-internet-protocols/125322

Related Content

General Introduction

Josephine Wapakabulo Thomas (2010). *Data-Exchange Standards and International Organizations: Adoption and Diffusion* (pp. 1-17).

www.irma-international.org/chapter/general-introduction/38114

Students' Experiences Composing and Decomposing Two-Dimensional Shapes in First and Second Grade Mathematics Classrooms

Drew Polly, Trisha Hilland Tabitha Vuljanic (2015). *Standards and Standardization: Concepts, Methodologies, Tools, and Applications* (pp. 1076-1091).

www.irma-international.org/chapter/students-experiences-composing-and-decomposing-two-dimensional-shapes-in-first-and-second-grade-mathematics-classrooms/125336

Participation in the Standards Organizations Developing the Internet of Things: Recent Trends and Implications

Justus Alexander Baron (2020). *Shaping the Future Through Standardization* (pp. 117-147).

www.irma-international.org/chapter/participation-in-the-standards-organizations-developing-the-internet-of-things/247398

Seizing Opportunities for the Support of Innovation through Committee Standards and Standardization: Insights from German Companies

Nizar Abdelkafiand Sergiy Makhotin (2014). *International Journal of IT Standards and Standardization Research* (pp. 38-56).

www.irma-international.org/article/seizing-opportunities-for-the-support-of-innovation-through-committee-standards-and-standardization/121704

Standards Development as Hybridization

Xiaobai Shen, Ian Graham, James Stewartand Robin Williams (2013). *International Journal of IT Standards and Standardization Research* (pp. 34-45).

www.irma-international.org/article/standards-development-as-hybridization/83546