Chapter 16
A Techno-Economic Perspective of Constrained Application Protocol

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ABSTRACT

Among billions of Internet enabled devices that are expected to surround us in the near future, many will be resource constrained, i.e., will have limited power supply, processing power and memory. To cope with these limitations, the Constrained Application Protocol (CoAP) has been recently introduced as a lightweight alternative to HTTP for connecting the resource limited devices to the Web. Although the new protocol offers solid technical advantages, it remains uncertain whether a successful uptake will follow, as it depends also on its economic feasibility for the involved stakeholders. Therefore, this paper studies the techno-economic feasibility of CoAP using a systematic methodological framework. Based on eleven expert interviews complemented with a literature survey, the paper identifies potential deployment challenges for CoAP, both technical and business-related, and suggests approaches to overcome them. The findings should facilitate the uptake of CoAP by supporting the potential adopters of the protocol in their decision-making.

INTRODUCTION

INTERNET of Things (IoT) envisions to connect billions of devices to the Internet. However, many of these devices, known as smart objects, have limited power supply, processing power and memory (Lerche, Hartke, & Kovatsch, 2012). The market is currently dominated by the in-house solutions and proprietary protocols, which are now being challenged by sector specific protocols, such as ZigBee and Z-wave, as well as by stardard protocols, such as Bluetooth Low Energy (Gallen, 2014). On the other hand, the widely deployed HyperText Transfer Protocol (HTTP) is believed to be a poor match for resource-constrained devices because of its chatty communication model and reliance on the stateful transmission control protocol (TCP) (Bormann, Castellani & Shelby, 2012).

To overcome the limitations of HTTP and to provide a standardized alternative to the sector specific protocols, the Internet Engineering Task Force (IETF) has introduced the Constrained Application Protocol (CoAP) (Shelby, Hartke, Bormann and Frank, 2013), which is designed specifically for constrained nodes and networks. CoAP is a simplified and optimized alternative to HTTP, which allows easy mapping between the two protocols (Bormann et al., 2012). The advantage of CoAP is that it supports efficient communication between resource-limited devices (Villaverde, Pesch, Alberola, Fedor & Boubekeur, 2012) by providing a generic HTTP-like protocol with small communications overhead (Shelby, Hartke, et al., 2013). As a generic application-layer protocol, CoAP can potentially be used to connect arbitrary things to the Web without the business sector specific limitations of other protocols. Therefore, CoAP is suitable for a wide range of application scenarios, including home automation, smart energy, street lightning, and asset tracking.

The performance gains attainable through the use of CoAP have been the focus of recent research efforts. Colitti et al. (Colitti, Steenhaut & Caro, 2011) studied the energy consumption of CoAP and HTTP data transfers and found that for frequent request-response sessions, CoAP allows the energy footprint to be cut roughly by 50% compared to HTTP. Levä et al. (Tapio Levä, Mazhelis and Suomi, 2013) found that the use of the CoAP's "observe" option in push-like applications enables a factor of six reduction in the energy footprint. Furthermore, the CoAP's energy impact and smaller communication overhead, when combined with a large number of frequently communicating devices, provides significant cost savings for CoAP-based solutions compared to the HTTP-based ones. Finally, Bandyopadhyay et al. (Bandyopadhyay & Bhattacharyya, 2013) compared the energy footprint of CoAP and MQTT for the push-like applications, and found CoAP to systematically outperform MQTT, due to data overhead of latter caused by its reliance on TCP and the inclusion of the topic definitions in the payload.

Nevertheless, the performance improvements alone cannot guarantee the success of CoAP, since a protocol needs also be economically feasible for the potential adopters and other stakeholders participating in protocol deployment. Analyzing the feasibility of CoAP is crucial in order to target it to the most suitable use cases, to identify its potential deployment challenges and to suggest strategies to foster its deployment. Therefore, this paper applies the framework of Levä and Suomi (Tapio Levä & Suomi, 2013) to analyze the feasibility of CoAP from the techno-economic perspective. The data are collected by reviewing the literature and interviewing eleven IoT experts with both technical and business expertise.

The remainder of the paper is organized as follows: Section II introduces the research methods, including the feasibility analysis framework and the interview process. Then Section III presents the necessary background on the technical architecture, deployment actions, stakeholder roles and deployment environment of CoAP. Section IV analyzes the interview results concerning the techno-economic feasibility of CoAP. Finally, Section V discusses the role of CoAP in the evolving IoT ecosystem, before Section VI concludes the paper.

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