

Lightweight Wireless Web Service Communication Through Enhanced Caching Mechanisms

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ABSTRACT

Reducing the size of the wirelessly transmitted data during the invocation of third-party Web services is a worthwhile goal of many mobile application developers. Among many adaptation mechanisms that can be used for the mediation of such Web service invocations, the automated enhancement of caching mechanisms is a promising approach that can spare the re-transmission of entire content fields of the exchanged messages. However, it is usually impeded by technological constraints and by various other factors, such as the inherent risk of using responses that are not fresh, i.e., are not up-to-date. This paper presents the roadmap, the most important technical and algorithmic details, and a thorough evaluation of the first solution for generically and automatically enriching the communication with any third-party Web service in a way that cached responses can be exploited while a freshness of 100% is maintained.

Keywords: Adaptation, Caching, Mobility, Proxy, Web Service, Wireless

INTRODUCTION

It seems that we are in the middle of an era where the spectrum of computing and bandwidth capacities is being stretched in both directions. At one end, highly capable systems are enabled through the Cloud and the continuous enhancements of the hardware, as well as of the communication media. At the opposite end, more limited, handheld, embedded, and mobile

devices are taking over the market in a scale that inspires some people to argue that we are finally entering the “post-PC era,” which has already been proclaimed as early as 1999 (Press, 1999). Like any technology that inter-operates between very different systems, Web service technologies must be an efficient solution for systems of both mentioned ends as well as the systems in between these two extremes. For this, they have to be adaptable to the entire computing and bandwidth spectrum in which they are used. Thus, Web service technologies

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have to focus on the needs of all their main application domains.

Undoubtedly, enterprise systems have been the application domain where Web services gained importance, being the most common technology for implementing Service-oriented Architectures (SOA) (Papazoglou & Heuvel, 2007). However, “everyday apps” might already be an equally important class of Web service consumers. Independently of which is the main application domain for Web services, the involvement of wireless devices as Web service consumers is increasing in both of them. A recent survey of TechTarget (Frye, 2009) positioned Web service-based mobile apps at the second place in the category “service-based implementations planned for the future” (planned by 60% of the questioned developers/companies), even higher than the “composite application assembly” (planned by 58%), which has been often named as the main potential of SOA (Papazoglou & Heuvel, 2007). The popularity of Web service technologies is due to the interoperability and platform-independence that are achieved through the self-description of the interfaces and the messages, but it is exactly this self-description that causes some communication overhead, for which Web services have been criticized since they appeared (Davis & Parashar, 2002). Enterprise systems may be affected by that only rarely but the same is not true for wireless devices.

Although some argue that the constraints of mobile devices (limited bandwidth, CPU, memory, or energy resources) are disappearing due to technological progress and such devices are “riding the wave of Moore’s Law” (Christin, Reinhardt, Kanhere, & Hollick, 2011), the gap between communication requirements and such device’s capabilities will not cease to exist. This is indicated by the latest analyses of future wireless communications. In the book of Sesia, Toufik, and Baker (2009) about LTE (Long Term Evolution of 3G mobile networks), five categories of user equipment are defined, with smartphones being placed only in the second or third category. According to this categorization, devices of higher categories will be able

to use wireless internet connection rates up to six times greater than those of lower categories. Furthermore, the wired connections of the future will be even faster than that, not to mention the fact that devices less capable than smartphones, such as sensor nodes, will be able to consume Web services. So, the big differences in device capabilities and connection qualities will maintain the need for adaptation of communication methods, as the size of the data that is processed and wirelessly transmitted is growing parallel to all other technological developments (Canali, Colajanni, & Lancellotti, 2009).

Therefore, most of the approaches that have appeared for reducing the overhead of Web service communication focus on wireless systems or are even specially designed for them. Client-side caching of Web service responses is such a broadly used lightweight technique and many different algorithms and strategies exist for it. However, all client-side caching algorithms contain some risk of using information that is not fresh, i.e., up-to-date. If one wants to be sure that the freshness of information is guaranteed, a new service request has to be sent. Due to technical restrictions that will be explained in the upcoming sections, (XML-based) Web services always transmit a complete response when they receive a request. Thus, the following research question arose: “How can Web services exploit the caching concept, i.e., the reuse of information from former responses, but with certainty that they are up-to-date?”

In Papageorgiou, Schatke, Schulte, and Steinmetz (2011) we presented a mediator-based solution for enabling freshness-safe client-side caching of SOAP responses. This has been achieved thanks to the innovative idea of enabling the automated and generic (i.e., service-independent) generation of a particular type of caching proxies. The article-at-hand takes the mentioned work further by analyzing the vision that led to the described solution, by offering a description of how the proxy generation logic can be realized, and by providing an extended evaluation that demonstrates the possible benefits of the approach in different Web service usage scenarios.

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