Cuckoo: A Computation Offloading Framework for Smartphones

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Abstract. Offloading computation from smartphones to remote cloud resources has recently been rediscovered as a technique to enhance the performance of smartphone applications, while reducing the energy usage.

In this paper we present the first practical implementation of this idea for Android: the Cuckoo framework, which simplifies the development of smartphone applications that benefit from computation offloading and provides a dynamic runtime system, that can, at runtime, decide whether a part of an application will be executed locally or remotely. We evaluate the framework using two real life applications.

Keywords: Mobile Computing, Computation Offloading.

1 Introduction

In the last decade we have seen, and continue to see, a wide adoption of advanced mobile phones, called smartphones. These smartphones typically have a rich set of sensors and radios, a relatively powerful mobile processor as well as a substantial amount of internal and external memory. A wide variety of operating systems [1,2,3,4] have been developed to manage these resources, allowing programmers to build custom applications.

Centralized market places, like the Apple App Store [5] and the Android Market [6], have eased the publishing of applications. Hence, the number of applications has exploded over the last several years – much like the number of webpages did during the early days of the World Wide Web – and has resulted in a wide variety of applications, ranging from advanced 3D games [7], to social networking integration applications [8], navigation applications [9], health applications [10] and many more.

Not only has the number of third-party applications available for these mobile platforms grown rapidly – from 500 [12] to 200,000+ [13] applications within two years for the Apple App Store –, but also the smartphones’ processor speed increased along with its memory size (see Figure 1), the screen resolution and the quality of the available sensors. Furthermore, the cell networking technology grew from GSM networks allowing for 14.4 kbit/s to the current 4G networks that will provide around 100 Mbit/s, while simultaneously the local wireless networks increased in bandwidth [14,15].

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Today’s smartphones offer users more applications, more communication bandwidth and more processing, which together put an increasingly heavier burden on its energy usage, while advances in battery capacity do not keep up with the requirements of the modern user.

The original idea of offloading computation from a thin client to a rich server is well known from a speed performance point of view. Only recently, it has been recognized that offloading computation using the available communication channels to remote cloud resources can also help to reduce the pressure on the energy usage [16,17,18].

In this paper we elaborate on the idea of computation offloading and present a practical system, called Cuckoo, that can be used to easily write and efficiently run applications that can offload computation. Cuckoo is targeted at the Android platform, since Android provides an application model that fits well for computation offloading, in contrast with other popular platforms, such as the iPhone.

Cuckoo offers a very simple programming model that is prepared for mobile environments, such as those where connectivity with remote resources suddenly