Chapter 9
Using MapReduce Framework for Mobile Applications

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ABSTRACT

Most of today's smart-phones are geared towards a single user experience, whether it is reading a book, watching a movie, playing a game or listening to music. However, there has been a shift towards providing a more complex and social experience: applications are being developed and deployed to help users connect and share information with each other. These applications allow people to keep track of their friends' statuses in real time, or to help them navigate around traffic congestion. While exciting, most such applications are currently being developed in an ad-hoc nature, reinventing and duplicating a lot of work to support their distributed operations. In this work, we present our framework, Misco. A platform for developing distributed applications for mobile smart-phones. We also explore some existing solutions, applications and related systems. We then discuss some of the many future research paths and show that solutions like ours are just the beginning.

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INTRODUCTION

Smart-phones are everywhere. There are currently over four billion active subscribers and that number of subscribers continues to grow. Smart-phones are also becoming more powerful. The latest generation of smart-phones boasts 1 *gigahertz* (*GHz*) Snapdragon processors, 512 *megabytes* (*MB*) of *Random Access Memory* (*RAM*) and 32 *gigabytes* (*GB*) of persistent storage (HTC, 2010). Network connectivity is also expanding and getting faster with *International Electrical Electronic Engineers* (*IEEE*) 802.11n, *Wireless Fidelity* (*WiFi*) and *Fourth Generation* (*4G*) cell networks. In addition to their increasingly powerful resources, smart-phones are being equipped with motion sensors, proximity sensors, *Frequency Modulation* (*FM*) receivers, *Global Positioning System* (GPS), digital compass, cameras and microphones.

All these factors combine to make smart-phones a very lucrative platform for developing distributed applications. Phone sensors provide environmental data such as sound, connectivity, movement, images and social information from user input, user interaction, contact lists and locations. Even more complex sensors are being developed and embedded into phones, such as sensors that detect deceases (Breslauer, Maamari, Switz, Lam & Fletcher, 2009) and air pollution (Honicky, 2010).

To take advantage of these phones, development and deployment of distributed applications must be simplified. There are many factors leading to the complicated nature of distributed applications: concurrency, resource allocation, software distribution, and device and network failures. These issues are further compounded by the hurdles of developing software on any of the current major smart-phones. In order to leverage the power of these devices, we must provide programming constructs that simplify the development and deployment of the applications.

We propose to use MapReduce as distributed computation framework for mobile devices. Since its introduction, MapReduce (Dean & Ghemawat, 2004) has grown immensely in popularity, supporting a wide array of applications spanning machine learning, simulations and media processing (Chen & Schlosser, 2008). MapReduce is being heavily used by prominent companies such as Google, IBM, Yahoo and Facebook to tractably process their large amounts of information. Although MapReduce started as a framework geared to run on systems in large data centers, it has been successfully implemented for other environments such as *Graphics Processing Units* (*GPUs*)(He, Fang, Luo, Govindaraju, & Wang, 2008), shared memory systems (Ranger, Raghuraman, Penmetsa, Bradski, & Kozyrakis, 2007) and even JavaScript clients on browsers (Grigorik, 2009). There have been some recent explorations with implementations of MapReduce on smart-phones (Dou, Kalogeraki, Gunopulos, Mielikainen & Tuulos, 2010; Marinelli, 2009; Elespuru, Shakya & Mishra, 2009). We feel that MapReduce's support for the weak connectivity model of computations across open networks makes it very suitable as a framework for smart-phones and mobile devices.

In this chapter, we first explore the current state and recent trends of smart-phones and a few recent projects focused on using mobile devices. Then, we explain the basics of MapReduce and discuss some of the recent advancements and several MapReduce implementations. We present Misco, a MapReduce framework we have developed for smart-phones and finally look at some of the issues and future work in this area.

BASICS OF MAPREDUCE FRAMEWORK

Smart-phones have been becoming increasingly powerful and are the fastest growing segment in the mobile devices market (Gartner, 2010). A simple look at the evolution of successive generations of