Chapter 4.10
Facilitating Biodefense Research with Mobile-Cloud Computing

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ABSTRACT

This paper proposes the use of a mobile-cloud by combining mobile devices and the cloud together in a biodefense and emerging infectious diseases (BEI) research application scenario. A mobile-cloud framework is developed to facilitate the use of mobile devices to collect data for, and manipulate and interact with the scientific workflows running in the Cloud. In this framework, an independent trusted accountability service is used to provide data provenance and enforce compliance among the participants of a biodefense research workflow. The authors have implemented a prototype which allows the researchers to use mobile devices to design and participate in biodefense workflows. The authors evaluated the effectiveness of the mobile-cloud with a prototype and conducted performance testing with example biodefense workflows.

INTRODUCTION

Each year, 25 per cent of human deaths are attributed to infectious diseases. Infectious diseases lie at the center of international interest due to many global occurrences. For example, the outbreaks of swine influenza in Northern Ireland, the global Severe Acute Respiratory Syndrome (SARS) epidemics, outbreaks of bovine spongiform encephalopathy and foot-and-mouth disease in the UK. Those Emerging Infectious Diseases (EIDs) dramatically impact on business travel, tourism, animal production, global economies,

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and public health at large (Binder, Levitt, Sacks, & Hughes, 1999; Jones et al., 2008). The main aim of biodefense and emerging infectious diseases (BEI) research is to alleviate vulnerability to emerging infectious diseases. In BEI research the method of surveillance and diagnosis is essentially important because over 70 per cent of EIDs originate in wildlife that lives far from the BEI laboratories. The under-reporting of disease events in the remote field has been identified as an enormous surveillance gap. Incomplete EIDs surveillance information reduces the capacity for early detection of infectious disease. The main source of animal health surveillance information has traditionally been collected from field investigations by veterinarians or wildlife observers, who usually provide DNA samples to the laboratories for further analysis if required. Any delays in DNA sample submission to BEI laboratories or disease research on the samples reduce the effectiveness and efficiency of surveillance. As a result, people are threatened with unwanted diseases.

When investigating disease events in a remote area, measurement data and DNA samples are often inputted into the mobile computing devices held by the investigator. The devices can be PDAs, smart phones or tablet computers, which usually have limited resources (CPU, memory, disk, tools and reference data) to conduct in-depth analysis. Any further research on the data and DNA samples needs to be performed in large scientific laboratories, assuming the investigator is able to access these facilities at anytime and anywhere.

The emergence of computing resource provisioning known as the Cloud has revolutionized contemporary computing. It provides a cheap and yet reliable outsourcing model for whoever has dynamic needs for scalable computing resources. Given the fact that many scientific breakthroughs need to be powered by advanced computing capabilities that help researchers manipulate and explore massive datasets (Lu, Jackson, & Barga, 2010), the Cloud offers the promise of 'democratizing' the research platform, as a single researcher or small team can have access to shared computing infrastructures similar to those of large, well-funded research organisations without the need to invest in purchasing and hosting them physically.

Therefore, we propose a mobile-cloud concept to combine mobile computing and cloud computing together as a solution to BEI collaborative research. From a mobile computing point of view, a handheld device provides a way to trace the location of disease events in real time through its Global Positioning System (GPS) functionality. A handheld inspects initial and fresh information (e.g., DNA microarray) via portable microarray technologies, and then submits to the Cloud immediately for further processing by starting a workflow. People can design and participate in a workflow to examine the DNA microarray at anytime and anywhere via the Internet. On the other hand, the Cloud computing provides many benefits for mobile applications. Compared with limited computing environments, the Cloud can enhance the computation capability of mobile applications, ranging from its high performance CPUs to huge amounts of data storage. Besides, there are a variety of software, tools and data available in the Cloud to be used as services. They provide high availability (24/7); low initial investment; high quality of service; low maintenance costs; high robustness; and quick recovery. These features have significantly changed the landscape and capability of mobile computing.

However, the combination of mobile application with cloud services comes with number of challenges. The key issues are *interoperability provenance and security*. Both mobile applications and cloud services can exist in many devices or OS. But there are great differences among these devices; and this heterogeneity affects the availability and usability of communication among handheld devices and the services in the Cloud. Thus we need a uniform communication mechanism between mobile devices and the Cloud.

The concept of Service Oriented Architecture (SOA) is a set of design principles used during the