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Aura: An Incentive-Driven Ad-Hoc IoT Cloud Framework for Proximal Mobile Computation Offloading

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Abstract

The rapid growth of mobile applications requires enhanced computational resources in order to ensure better performance, security, and usability. In recent years, the proliferation of the Internet-of-Things (IoT) devices has caused a paradigm shift in computing and communication. IoT devices are making our physical environment and infrastructures smarter, bringing pervasive computing to the mainstream. Given numerous predictions that we will have billions of such devices deployed in the next five years, we have the opportunity to utilize such IoT devices in converting our physical environment into interactive, smart, and intelligent computing infrastructures. In this paper, we present Aura – a highly localized IoT based cloud computing model. Aura allows mobile clients to create ad hoc and flexible clouds using the IoT and other computing devices in the nearby physical environment. Aura provides localized computational capability from untapped computing resources using a task-offloading model for mobile devices. Computations done in Aura are highly flexible, giving clients full control to start, stop, migrate, and restart computations in localized IoT devices as the mobile users move between different physical locations. As an example application of Aura, we have ported a lightweight version of MapReduce to run on IoT devices powered by Contiki OS. The prototype application was utilized to conduct various experimental measurements to evaluate different performance metrics of the proposed system. The paper presents a detailed comparative analysis of Aura with traditional clouds and applications running natively on mobile phones to assert the benefits and feasibility of the model.

Keywords: Mobile cloud, Internet of things, Fog Cloud, Edge Network, MapReduce

1. Introduction

The emergence of cloud computing has created a major shift in our general computing practices. Cloud service providers use large data centers, which, in most cases, are placed in geographically distant locations from their clients[1]. A client therefore must send and receive its data over the public Internet and over long distances when using such clouds. As an example, let us consider a cloud-enabled mobile application running on a smart phone [2]. For the lower computation capability of mobile phone processors, such an application would ideally offload all the computation to the cloud, and provide only the visual display of the application on the phone. However, traditional clouds located hundreds or thousands of miles away from the mobile phone client may introduce latencies which is large enough to cause sluggish performance and availability problems for the cloud-enabled application. To provide optimal performance and least amount of data movement between the client and the cloud, it would be better if the cloud is physically close to the client and moves as the client changes her location over time.

On the other hand, building cloud infrastructures is very expensive, requiring millions of dollars to set up and operate cloud data centers. It is therefore impossible and economically infeasible to have data centers located near clients. In order to provide such localized computing facilities, we need a very lightweight system for outsourced computations that can be incorporated into each building or physical infrastructure, making them available at a very close distance from mobile clients. To achieve this, in this paper, we present *Aura* – a system for outsourced computation on lightweight ad hoc clouds built using low powered Internet-of-Things devices.

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