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Optimal mobile device selection for round-robin data exchange via adaptive multi-criteria decision analysis☆

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ABSTRACT

In recent years, exchanging data has become far easier with the rapidly growing popularity and increased mobility of mobile devices. However, data exchange between mobile devices is performed as a peer-to-peer communication. Each mobile device that serves as a candidate has a whole range of hardware statuses which may influence data exchange performance. Thus, the selection of a mobile device with sufficient computing resources to facilitate round-robin data exchange is an interesting process worth exploring. This study proposes an optimal mobile device selection approach for round-robin data exchange via the monitoring of the hardware status of each candidate device's system profile. A case study demonstrates the proposed approach, step by step. The experimental results show that the proposed approach can be used to improve round-robin data exchange performance. The contribution of this study is to provide an approach which selects an optimal candidate mobile device for round-robin data exchange in a local wireless communication network.

1. Introduction

As information and communication technology has evolved, data exchange has always been an essential and important process. People exchange signals, messages, or data files with each other. The relatively recent emergence of mobile devices has changed our life-style in general. People using mobile devices such as smartphones or tablet computers are constantly creating data. The popularity and mobility of mobile devices have made the exchange of data more convenient [1]. The traditional limitations of mobile devices (e.g., low computing power, limited memory and storage space, or insufficient battery life) have been mitigated with the advent of cloud computing, remote storage, and application services. Various built-in data transmission mechanisms (e.g., Bluetooth, Wi-Fi, Wi-Fi Direct, and Near Field Communication [NFC]) also facilitate the easy exchange of data between mobile devices. However, in a local wireless communication network, data exchange between mobile devices is performed as a peer-to-peer communication [2]. Each mobile device is considered as a candidate, and each has a different hardware status (e.g., central processing unit [CPU] loading, memory usage, storage space, battery life,

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Wi-Fi signal strength, etc.) which may affect the performance of the data exchange. The selection of a reasonable mobile device with sufficient computing resources to facilitate round-robin data exchange is an interesting process worth exploring.

Real-world problems are typically hard to resolve because uniquely optimal solutions do not exist, so the condition and relevant status of the decision-maker are used to differentiate between solutions. In this study, we focus on the mobile device's system profile which indicates the status of a variety of factors, any or all of which may influence the data exchange performance between mobile devices. Multi-criteria decision analysis (MCDA) [3] is one approach to solving multi-dimensional problems. MDCA can support decision making by resolving problems encountered when selecting between various candidates. To enhance MCDA effectiveness in a round-robin data exchange scenario, an adaptive mechanism is employed to store previous rounds' results, to evaluate the current context status, and to adaptively adjust parameters for the next selection round. Status item are the criteria which are evaluated via the multi-criteria decision analysis method to rank the candidates in order. The ranking order supports the decision-making process for selecting a reasonable candidate.

To date, mobile operating systems have yet to include a built-in, automatic optimal selection mechanism to assist data exchange between devices. Users are therefore required to carry out a device-by-device selection process for each round of data exchange. However, because hardware statuses vary among mobile device systems, evaluating user selection time is an NP problem, and it depends on user preferences or considerations. This study proposes an optimal mobile device selection approach for round-robin data exchange via the monitoring of the hardware status of each mobile device's system profile. The approach can be implemented as a built-in system mechanism that does not require user intervention. At the completion of each data exchange round, an adaptive function adjusts the criteria evaluation in order to obtain a more adaptive ranking order of candidate mobile devices for the next round. The contribution of this study is to provide an approach which is easily implemented in a mobile device and can always select the optimal candidate device during a round-robin data exchange in a local wireless communication network.

The remainder of this paper is organized as follows. Section 2 introduces related studies. Section 3 presents a new approach for round-robin data exchange over a mobile wireless communication network. A case study is detailed in Section 4, and the experiments and a relevant discussion are contained in Section 5. Finally, Section 6 presents our conclusions.

2. Related works

This section contains a review of related literature, including studies on mobile data exchange and multi-criteria decision-making.

2.1. Mobile data exchange: transmission protocols and security

Various built-in data transmission mechanisms such as Bluetooth, Wi-Fi Direct, Session Initiation Protocol (SIP) and Juxtapose (JXTA) have been designed to support data exchange between mobile devices [2]. Cao et al. [4] proposed a blood glucose monitoring system using Bluetooth and a 3G mobile phone network. The system automatically detects the real-time blood glucose status of diabetic patients, which is immediately transmitted to a monitoring center via Bluetooth transmission protocols. If a patient's status is abnormal, their mobile phone's GPS is used to obtain their location, and the proposed system sends an alert to the monitoring center. Kim and Jung [5] used Wi-Fi Direct to implement a "smart meeting" Android application called CyberOffice, which facilitates presentations even when beam projectors and computers are unavailable. Lin et al. [6,7] used SIP to construct a distance education system for m-learning. Rajkumar et al. [8] used JXTA/JXME to design a healthcare management system for mobile streaming applications, which allows patients and healthcare workers to exchange messages and transmit data over a peer-to-peer (P2P) network. Tsai et al. [9] designed a mobile social software (MoSoSo) based on a P2P network architecture using Juxtapose (JXTA) and Juxtapose for Java MicroEdition (JXME). This MoSoSo application allows students to exchange data using mobile devices. Barolli et al. [10] proposed a JXTA-based P2P platform designed to utilize the capabilities of Java, JXTA and P2P technologies to support distributed and collaborative systems. The platform communicates with remote devices via JXTA, and controls a learning environment for more effective learning.

In exploring data security, some studies have used symmetric encryption methods to encrypt data and enhance the security of mobile data exchange. Qian et al. [11] used data encryption standards (DES) and chaotic encryption to design a new image encryption schema for protected image security and reliability. Arnedo-Moreno et al. [12] explored the security of JXTA-based applications and found that the message transmitted in the protocol should be encrypted with DES in advance in order to ensure the security of the transmission process. Cheng et al. [13] produced an authentication image using the HMAC One Time Password algorithm (HOTP) and mobile system time for user identification authentication. The authentication image was encrypted with DES to protect against data counterfeiting. Since some form of security mechanism is always required in a mobile transmission environment, this study uses symmetric encryption to protect the exchanged data.

2.2. Multi-criteria decision analysis (MCDA)

Multiple-criteria decision analysis (MCDA) is useful when the problem has multiple alternative solutions [14]. MCDA is divided into two categories based on the property or attribute of a solution. One is multi-objective decision-making (MODM),