

## Poster Abstract: Smartphone Heterogeneous Network Handoff Based on the Closed Control Loop

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**Abstract**—In this poster, we implemented a closed control loop solution that take exploit of heterogeneous networks technologies and eliminate the interruption of running apps in the smartphone.

### I. INTRODUCTION

Numerous research efforts have improved application performance and user experience on the mobile phone via collecting network usage characteristics and various context information. However, there is still a distinct gap between the application behavior and user satisfactory. One key reason is that most phone applications lack a feedback from user as well as the ambient environment. Note that such a feedback scheme can make applications adaptive to the changing context. In this work, we focus on a special application, i.e., the heterogeneous wireless network handoff, for the smartphone residing between. We propose a novel feedback scheme that takes ambient information and user experiences into consideration. We demonstrate that, by using such a scheme, the gap between the handoff and user satisfactory can be significantly reduced.

### II. OVERVIEW

Modern smartphones usually have multiple wireless interfaces, e.g., WiFi and 3G. A number of recent studies [1] propose to switch between WiFi and 3G to gain a better performance in terms of throughput, energy efficiency, and user experience. Intuitively, using WiFi for Internet accessing sometimes achieves higher throughput and lower energy cost than 3G, and however, may lead to frequent disconnections (e.g., on a moving car). Our general idea is to put this intuition into the interface switching policy. Our proposed feedback based interface switching paradigm is shown in Fig. 1.

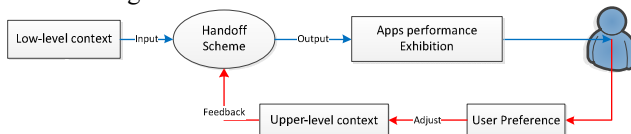


Fig. 1 The heterogeneous wireless networks handoff paradigm.

In Fig. 1, the network handoff is determined by two inputs: (1) low-level context information such as wireless signal strength, energy consumption, response time, packet loss rate and so on; (2) upper-level user feedback about the perceptual experience of application usage during the network handoff. We have used the cost-function for selection network as the handoff scheme, where low-level context is input parameter and upper-level feedback is the modification parameter. For exactly description user experience about the handoff policy, we have implemented a

third-party app to exhibit the changed performance of apps when the operation happened. Therefore, the end-user can give accurate feedback about the handoff policy. We detail the system design and implementation in the next section.

### III. SYSTEM DESIGN

We have implemented a service running on HTC G8 (android platform). The service runs at background gathering various data: (1) instantaneous message acquired directly via platform APIs, including RSSI, the amount of transfer, and interface status; (2) information acquired via period check thread, including the throughput, RTTs and running apps network parameters. We used the satisfaction degree function for end-users to evaluate each available network. The collected data are assigned a dynamic value of satisfactory degree according to the user feedback. We used the two approaches to represent the feedback of handoff usage. One way is the white/black list of apps. As web browsing holds almost one third time of smartphone activity [2], we also built the white/black list for web sites. The other way is end-user personal evaluation of the handoff policy. The scheme score is the form of individual assessment, which is also the modification of cost-function parameters. For the purpose of giving the accurate and realistic evaluation of handoff policy, we will prepare friendly GUI of third-party app to show the changing performance of each app when the switch operation happened.

We collected real-life smartphone traces for two days with five participants. Our preliminary experiment is shown in Tab. 1. The handoff scheme based on the closed loop has less effect on interruption of running apps, compared to the heuristic scheme based on RSS or data offloading. In Tab. 1, the closed loop handoff can reduce the distinct gap between user satisfactory and handoff influence, while taking exploit of heterogeneous network.

TABLE I. PRELIMINARY EVALUATION RESULTS

System	The Closed loop Handoff	Heuristic handoff (RSSI)	Heuristic handoff (offload data)
running apps	1.2 average	3.2 average	4.5average
switch time	13.42s	15.22s	16.36s

### ACKNOWLEDGMENT

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### REFERENCES

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- [2] Q. Xu, J. Erman and A. Gerber etc. Identifying Diverse Usage Behaviors of Smartphone Apps. In IMC, 2011.