

# A Crowdsourced WiFi Sensing System with an Endorsement Network in Smart Cities

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**Abstract**—As crowd-centric applications have attracted a lot of attention, this work exploits the crowdsourcing technologies to collect and share user experience of WiFi hotspots in an urban area. To address the *trust issue*, we incorporate an *endorsement network* into the system, where users can endorse others based on the reviews submitted by themselves. With the incentive endorsement network, our system can quantify the trustworthiness of data publishers to make the system more trustful. We have implemented our design as a mobile application for mobile devices to demonstrate how our system guides people to connect to WiFi hotspots and how the endorsement network works with the crowdsourced WiFi sensing system.

**Keywords:** Crowdsourcing, mobile sensing, participatory sensing, pervasive computing, smart cities.

## I. INTRODUCTION

Recently, sensor-enabled smartphones have boosted many crowd-centric application systems that incorporate *participatory sensing* [1] to capture urban dynamics for city planning purposes. Such crowdsourcing technologies are exploited to study human activities [2], transportation activity inference [3], and network quality [4][5] in an urban area.

This work embodies the concept of crowdsourcing to design a WiFi sensing system for a smart city, where users carry smartphones to contribute the network quality and detailed locations of the connected WiFi hotspots so as to help other people to connect to the better WiFi hotspots. However, *trust issue* is a critical challenge in such a crowdsourced WiFi sensing system in that sense that the system must be able to evaluate the trustworthiness of data publishers. To achieve this goal, we incorporate an *endorsement network* among all the users in the system so that users can submit not only reviews of WiFi hotspots but also the opinions on data publishers. Specifically, our system allows users to endorse others who submit trustworthy reviews of WiFi hotspots and thus form an endorsement network. Moreover, we further quantify the trustworthiness of users based on the number of submitted reviews and the number of endorsement earned by themselves. Our system has the following two unique features. Firstly, our system integrates an incentive endorsement network together with the crowdsourced WiFi sensing system to make the system more trustful. Secondly, our system will be able to launch gamification-based campaigns to collect the user experience of WiFi hotspots. In this work, we have implemented the crowdsourced WiFi sensing system as a mobile application for mobile devices (e.g., smartphones and tablets) to collect crowdsourced WiFi data and establish directional endorsement

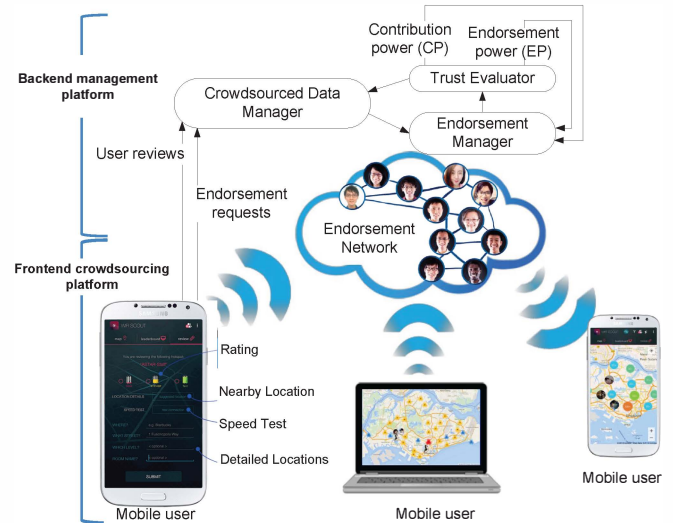


Fig. 1. System architecture.

links between users. We will demonstrate how our system guides people to connect to WiFi hotspots and how the endorsement network works with the crowdsourced WiFi sensing system.

## II. SYSTEM DESIGN

Fig. 1 shows the architecture of our system which is composed of two major parts, the *frontend crowdsourcing platform* and the *backend management platform*. The frontend crowdsourcing platform is responsible for collecting the currently connected WiFi information including the user rating, the nearby location and address, the uplink and downlink network speeds, and the detailed location information (e.g., room number or level number). The backend management platform consists of four components: (1) endorsement network, (2) crowdsourced data manager, (3) endorsement manager, and (4) trust evaluator. Our system allows all the users to endorse one another and thus form a simple endorsement network in the sense that the directional trust relationships between any two mobile users will be maintained by the system. In our system, each user will be associated with two power attributes based on a social-economic scheme [6], the *contribution power (CP)* and the *endorsement power (EP)*. The contribution power is evaluated based on the number of reviews submitted by the user himself/herself and by the endorsers who are endorsing

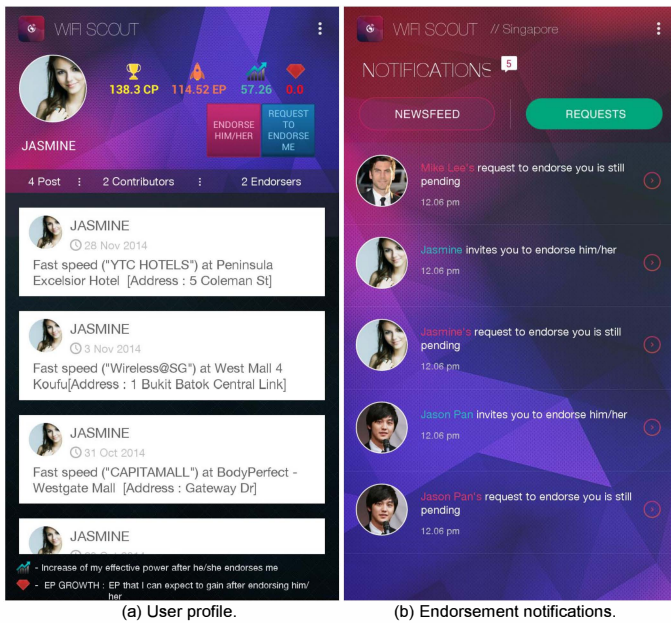


Fig. 2. Screenshots of our mobile application.

the user. The endorsement power is evaluated based on the number of reviews submitted by the contributors who are endorsed by the user. Therefore, for instance, user A endorsing user B implies both of the following two aspects: (i) user B is more trustworthy in our system and (ii) user A will earn EP when user B submits reviews. There are two simple ways to establish the trust relationship between user A and user B. Assume that user A wants to endorse user B. Firstly, user A can send user B a request to endorse him/her. Then, user B will be notified and decide whether to accept or reject the request. Secondly, user B also can request to be endorsed by user A, and user A will decide whether to accept or reject the request. With the endorsement network, when a mobile user submits a review of the currently connected WiFi network or sends endorsement requests, the crowdsourced data manager will inform the endorsement manager to update users' statuses in the endorsement network. The endorsement manager is responsible for invoking the trust evaluator to update the values of contribution power and endorsing power for these users accordingly.

### III. IMPLEMENTATION AND DEMONSTRATION

We implement our system, called *WiFi-Scout*, to collect the crowdsourced WiFi user experience in Singapore and guide users to connect to the better WiFi networks. Moreover, our WiFi-Scout [7][8] is available on Googly Play. The frontend sensing is implemented as a mobile application for the frontend crowdsourcing platforms, where the frontend crowdsourcing platforms could be either smartphones or tablets. Fig. 2 shows the screenshots of our WiFi-Scout mobile application. Fig. 2 (a) shows the user profile which includes the user name, avatar picture, the values of contribution power and endorsing power, contribution history (i.e., a list of posts), endorsers who are endorsing the user, and contributors s/he is endorsing. Fig. 2(b) shows the endorsement requests. In addition, WiFi-Scout can also provide a web service to serve users who are

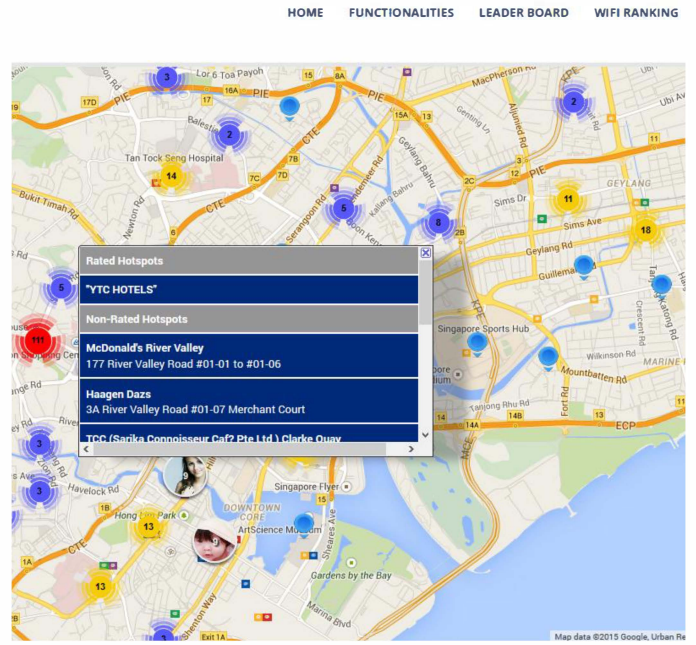


Fig. 3. A screenshot of the WiFi-Scout web service.

not using smartphones, as shown in Fig. 3, where our system accommodates both WiFi hotspots with user rankings and the ones without user rankings.

### IV. CONCLUSION

This work incorporated crowdsourcing technologies with an endorsement network to design a WiFi sensing system for smart-city applications, where we addressed the trust issue to quantify the trustworthiness of data publishers in the system. We implemented our design as a mobile application, called WiFi-scout, to collect the reviews of WiFi networks from users and establish the endorsement links among users.

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