Bustle: Using Hitchhiking to Monitor Meaningful Locations

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Abstract

Hitchhiking is a client-focused, software-based approach to anonymous and privacy-sensitive collection of sensed data in location-based applications. In this paper, we demonstrate hitchhiking by implementing a WiFi-based location-centric service called Bustle. Using only software sensors, Bustle models the busyness of coffee shops while incorporating hitchhiking principles to protect the anonymity and privacy of the application users.

1. Introduction

Hitchhiking is a client-focused, software-based approach to anonymous and privacy-sensitive collection of sensed data in location based services that differs from prior work [1,2,3]. Hitchhiking principles (Fig 1) aim to counter location-based privacy threats and uses existing devices and networks without the cooperation of a trusted server to provide full utility without reducing the precision of location reports [5].

1)	Location is computed on the client.
2)	Only the client device is trusted.
3)	Each person must approve reporting from a location.
4)	Physical constraints prevent location spoofing.
5)	Location identifiers are based in the physical location.
6)	Location identifiers are generated by the client.
7)	Sensed identifiers are not reported to the server.

Fig 1. Hitchhiking principles to preserve privacy & anonymity for sensed data in location-based apps

3. Bustle: Monitoring Coffee Shops

To demonstrate hitchhiking, we implemented Bustle, a location-centric service that senses WiFi-networked laptops and anonymously reports estimates of table availability in coffee shops. In a typical usage scenario, a person visits a coffee shop and works on his laptop. Running in the background, Bustle scans for nearby WiFi access points to see if the person is in a coffee shop [4]. After determining it is okay to report, Bustle monitors Address Resolution Protocol (ARP) broadcasts to count co-present devices. A server infers from the counts the shop's busyness.

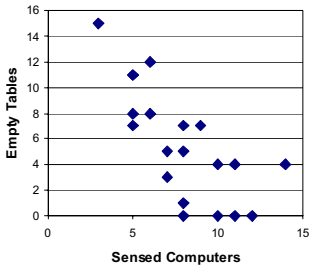

Fig 2. Feasibility data for Bustle's availability sensing

We conducted a small feasibility study of Bustle to test if the correlation between laptop usage and the number of people in a coffee shop is sufficient for inferring space availability. We made 20 visits to a laptop friendly coffee shop over 7 days, spacing visits by at least 90 min, aiming for 9AM-9PM coverage. On each visit, we monitored ARP broadcasts for 20 minutes and then counted the empty tables (Figure 2).

In the shop we sampled, there is a strong correlation between the number of computers on the network and the number of empty tables. In every case of no available tables, at least 8 computers were detected on the network. While the strength of this correlation will vary in different places, this result shows a learnable threshold for Bustle's WiFi-based busyness sensing.

Bustle's successful implementation can be extended to other location-centric applications as well. Examples include monitoring traffic conditions, conference room availability, and bus routes and space availability.

10. References

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