Improving Public Transit Applications by Utilizing Location Data

Related Work

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I. Public transit providers

Since the increasing adaption of smartphones, public transit providers have been publishing apps to provide information on their public transit services [1, 2]. These systems have been subject to continuous development and improvement. The introduced features have also included some location based once. Due to the scope of this paper the focus will be on the Apps of two public transit provider: *DB Navigator* from *Deutsche Bahn AG*, Germanys largest railway company and major market share holder in long distance public transit, and *VRR App* from *Verkehrsverbund Rhein-Ruhr*, a public transit association in the Ruhr area, which is the largest metropolitan area in Germany. Apps of other public transit providers possess similar features.

Although both applications request access to location data, the location is only used to determine the current position when explicitly requested by the user. During the navigation, location data is not used. Instead the current progress navigation is determined by the time passed since the start of the navigation. This approach requires the traveler to explicitly enter the route into the application to get information about it and is therefore somewhat tedious to frequent travelers.

Commuter friendly features are mostly limited to the ability to purchase and store commuter tickets and saving stops or routes as favorites. The "DB Navigator" additionally provides the option to place widgets on the home screen showing departure information for specific stops or providing quick access to favorites or tickets.

To be able to detect arriving trains, the VRR makes use of *Bluetooth Low Energy* beacons. The beacons are mounted in the trains and can be detected using the app. This has been found out by analyzing close by Bluetooth devices close to VRR vehicles. The app will use these beacons to detect that the user is close to the train and will be able to enter it. Similar approaches have been described by multiple authors [3, 4]. The advantage of using *Bluetooth Low Energy* beacons compared to traditional satellite location services is, that the energy consumption is much lower. The usage of this beacon might be useful for the implementation of *Onboard Train Detection*.

The *VRR App* is part of a public transit system in North Rhine-Westphalia, Germany called *eezy* [5]. This system allows users to check-in and check-out of public transit vehicles using a smartphone app. This does make use of the device location when checking in and out, but does only use a momentary snapshot of the location. The fair is then calculated based on the distance between the check-in and check-out location.

II. Long term tracking approaches

In contrast to *Check-In, Check-Out* described before, *Be-In, Be-Out* systems like described in [6], do not require passengers to manually check in and out of vehicles. Instead, the system tracks the passengers location continuously and detects when public transit is boarded and unboarded. This does drive up energy consumption, as location services are used continuously, but also increases convenience for the user, as the travel is automatically detected.

[7] describes a system, that starts tracking when the user checks into the transit and stops when the user checks out. The information is then matched up with bus schedules to calculate which routes specifically have been taken. The activation of location tracking only when the user is onboard public transit reduces the amount of energy the app uses when not actively used. In general, this approach is similar to the one used by the *VRR App* and *eezy*, the difference being that *eezy* uses only check-in and check-out locations and calculating the fair from the direct distance. This reduces the accuracy of the fare, but limits the energy used for location services even more. However *eezy* does use location services to remind you of checking out when leaving the train. While this does use some energy, the frequency and accuracy of location service usage and therefore the energy consumption can be assumed to be lower lower than when checking out is performed fully automatically.

III. Privacy

In many scenarios, it is not possible to maintain data privacy by performing all calculations locally. Often this is the case because the amount of data required to download would be far to large. Nevertheless, depending on the type of data, privacy can be maintained even when requesting data from the server when special algorithms like *k-anonymity* are used. *k-anonymity* is an algorithm first published in [8]. It retains privacy by structuring the query data in a way, that prevents the server from identifying the client and any personal data. Approaches exist that apply *k-anonymity* on location data [9, 10]. Wether this approach will be applicable and viable in this scenario will require further evaluation.

In general, maintaining data privacy especially in location data has proven to be a difficult task, even when the data is anonymized. In 2019 the New York Times published an article on an examined dataset of location data of twelve million phones. Even though the data was anonymized a large portion of the people tracked by the location services could be identified from few data points [11].

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