Trinity College Dublin

Coláiste na Tríonóide, Baile Átha Cliath

The University of Dublin

Estimating Passenger Flow & Occupancy on Board Public Transport Buses Through Mobile Participatory and Opportunistic Sensing

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Background

Collecting real time passenger flow and occupancy data usually involves using hardware such as cameras and pressure sensors to record passenger journeys. It's easy to imagine how expensive this can become at scale.

In 2014 Dublin bus had 945 buses and had spent 8 million euro implementing their RTPI (Real Time Passenger Information) system, demonstrating the importance of real time information to Dublin Bus and its passengers.

How is this data useful?

➢Bus operators, such as Dublin Bus, can reduce costs and environmental impact by optimising how their bus fleet is used based on passenger flow and occupancy data.

➢Passengers can enjoy a more comfortable journey in buses that are not so crowded.

➢Bus operators can become better at scheduling buses based on demand data.

➢Planning for future public transport in cities relies upon passenger flow data over time such as the data collected by this study.

Introducing PassengerSense

PassengerSense is a crowd sensing mobile application designed to help discover the relationship between the number of discoverable Bluetooth devices, the number of passengers connected to the buses Wi-Fi and the number of actual passengers on board the bus.

Participatory Sensing:

➢Participants who use the application can provide ground truth data about the true occupancy of the bus.

Opportunistic Sensing:

➢Data collected in the background without the users input is opportunistic. In this case Cell, Wi-Fi, and Bluetooth.

Estimating Passenger Occupancy:

➢Previous studies suggest that discoverable Bluetooth devices represent between (7.5 – 9.5 %) of the population.

Results (Rush Hour Data):

➢Correlation between Wi-Fi users and passengers: R = 0.796

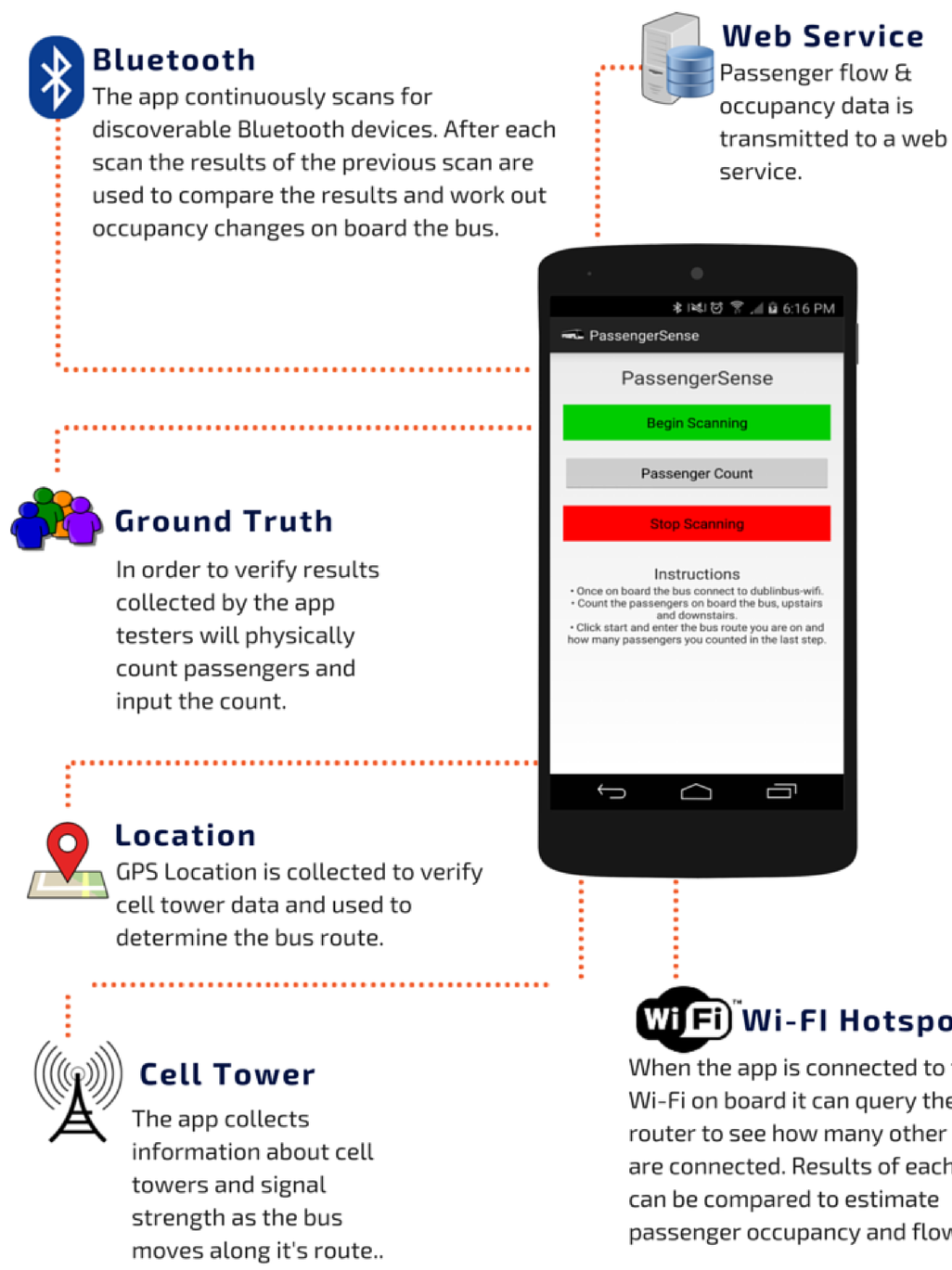
➢Classification Table (Bus Full/Not Full Binary Classification Model)

	Suc-Obs	Fail-Obs	
Full-Pred	15	5	20
Not-Full-Pred	10	92	102
	25	97	122
Accuracy	0.6	0.948454	0.877049

M.Sc. in Computer Science

(Networks and Distributed Systems)

How Does it Work?



Protecting Passenger Privacy

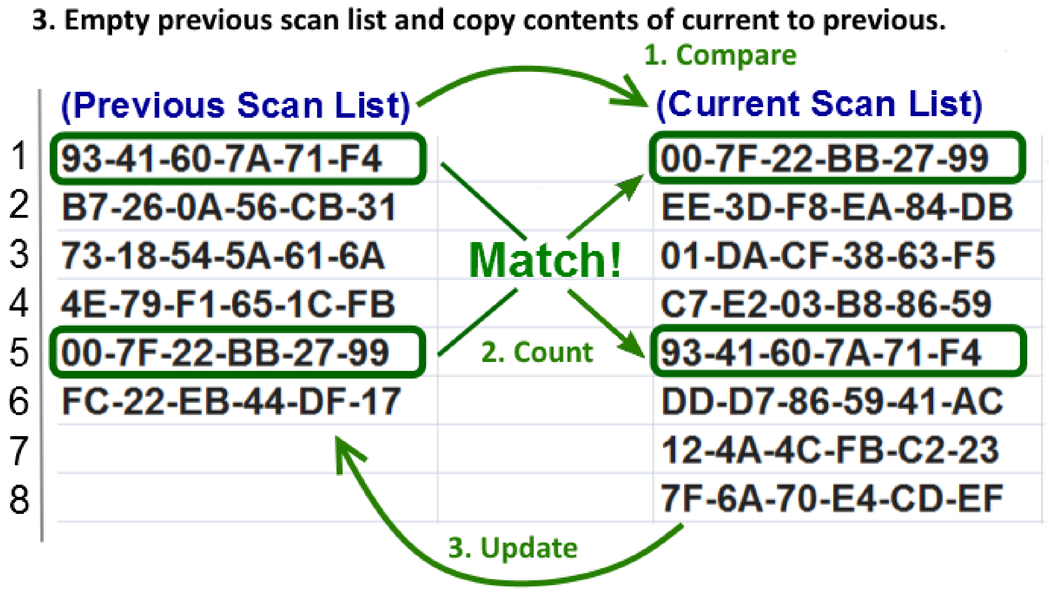
An algorithm enables counting of unique Bluetooth & Wi-Fi devices without the need to store MAC addresses or expose private data to the web service. Results of the algorithm are posted to a RESTful Web Service.

Previous Scan Results:

{"measurements":{"TotalHostsWi-Fi":6,"NewHostsWi-Fi":0},"eventDate":"2015-08-01T20:23:43.043+0000", "metadata":{"PipelineName":"WIFI_PING","api-key":"xxxxxxxxxxxxxxxx"}}

Current Scan:

1. Compare current scan to previous scan, looking for matching MAC addresses.
2. Count number of matching addresses and number of new addresses.
3. Empty previous scan list and copy contents of current to previous.



Current Scan Results:

{"measurements":{"TotalHostsWi-Fi":8,"NewHostsWi-Fi":6},"eventDate":"2015-08-01T20:23:43.043+0000", "metadata":{"PipelineName":"WIFI_PING","api-key":"xxxxxxxxxxxxxxxx"}}

School of Computer Science & Statistics (SCSS)

Faculty of Engineering, Mathematics and Science