Advances in Positioning

"SubwayPS: Towards Enabling Smartphone Positioning in Underground Public Transportation Systems"

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SubwayPS: Towards Smartphone Positioning in Underground Public Transportation Systems

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ABSTRACT

Thanks to rapid advances in technologies like GPS and Wi-Fi positioning, smartphone users are able to determine their location almost everywhere they go. This is not true, however, of people who are traveling in underground public transportation networks, one of the few types of high-traffic areas where smartphones do not have access to accurate position information. In this paper, we introduce the problem of underground transport positioning on smartphones and present *SubwayPS,* an accelerometer-based positioning technique that allows smartphones to determine their location substantially better than baseline approaches, even deep beneath city streets. We highlight several immediate applications of positioning in subway networks in domains ranging from mobile advertising to mobile maps and present *MetroNavigator,* a proof-of-concept smartphone and smartwatch app that notifies users of upcoming points-of-interest and alerts them when it is time to get ready to exit the train.

Categories and Subject Descriptors

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

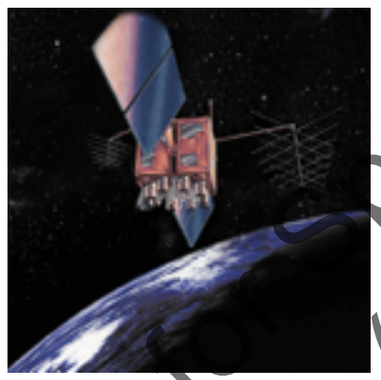
Keywords

mobile navigation, positioning, mobile devices,

Red dots are underground stations. One could easily miss their stop if they relied solely on current positioning

Key Types of Signal-based Positioning

in your smartphone and in general

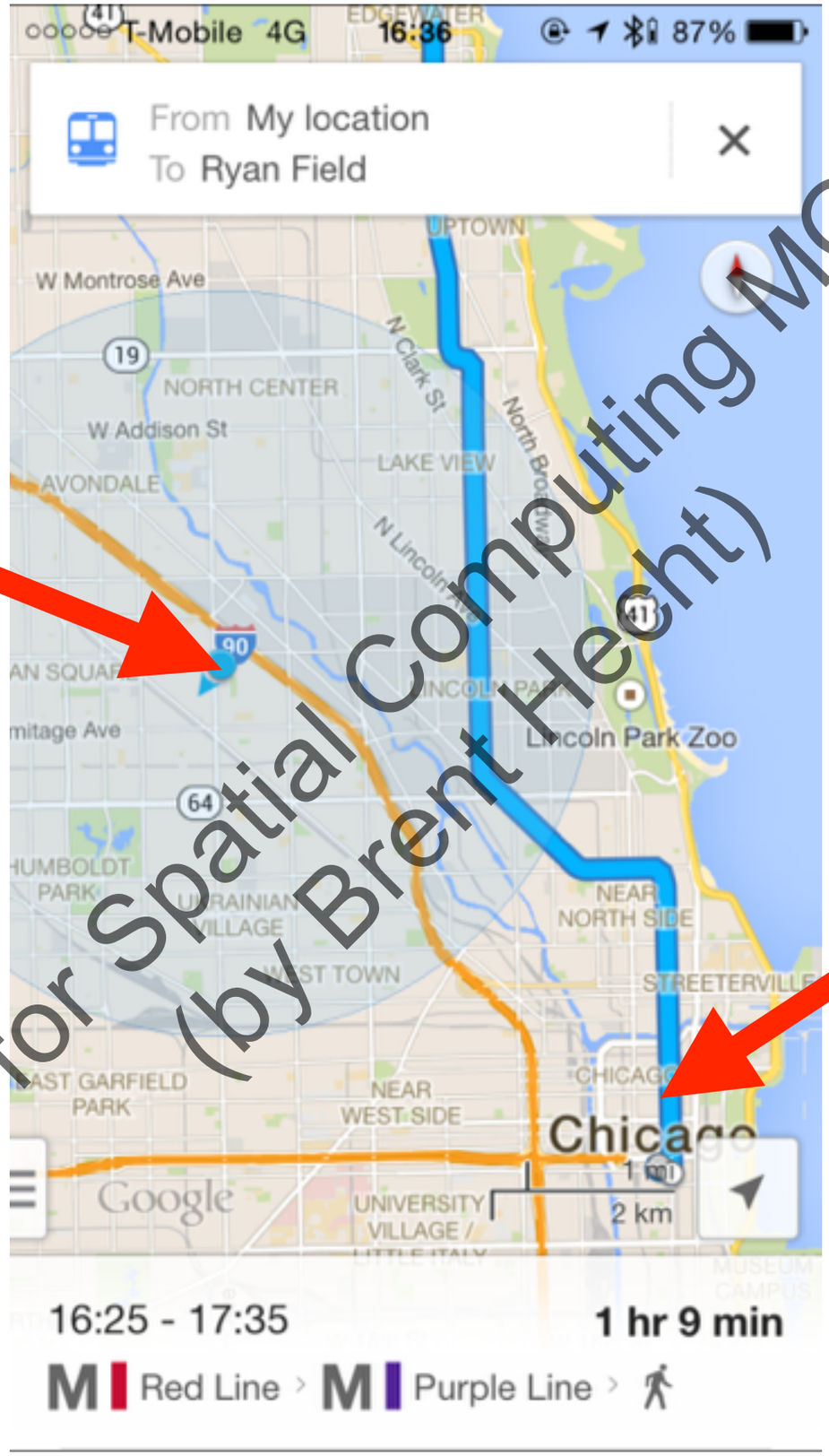


Signal-based Positioning

1. Satellite-based Positioning
2. Wifi Positioning
3. Cellular Positioning

GNSS Wifi Cell

Rural areas



Location-based advertising using subway positioning:

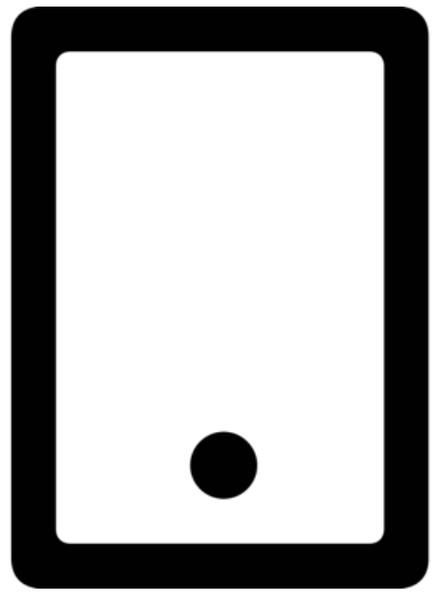
Sensors

Wifi

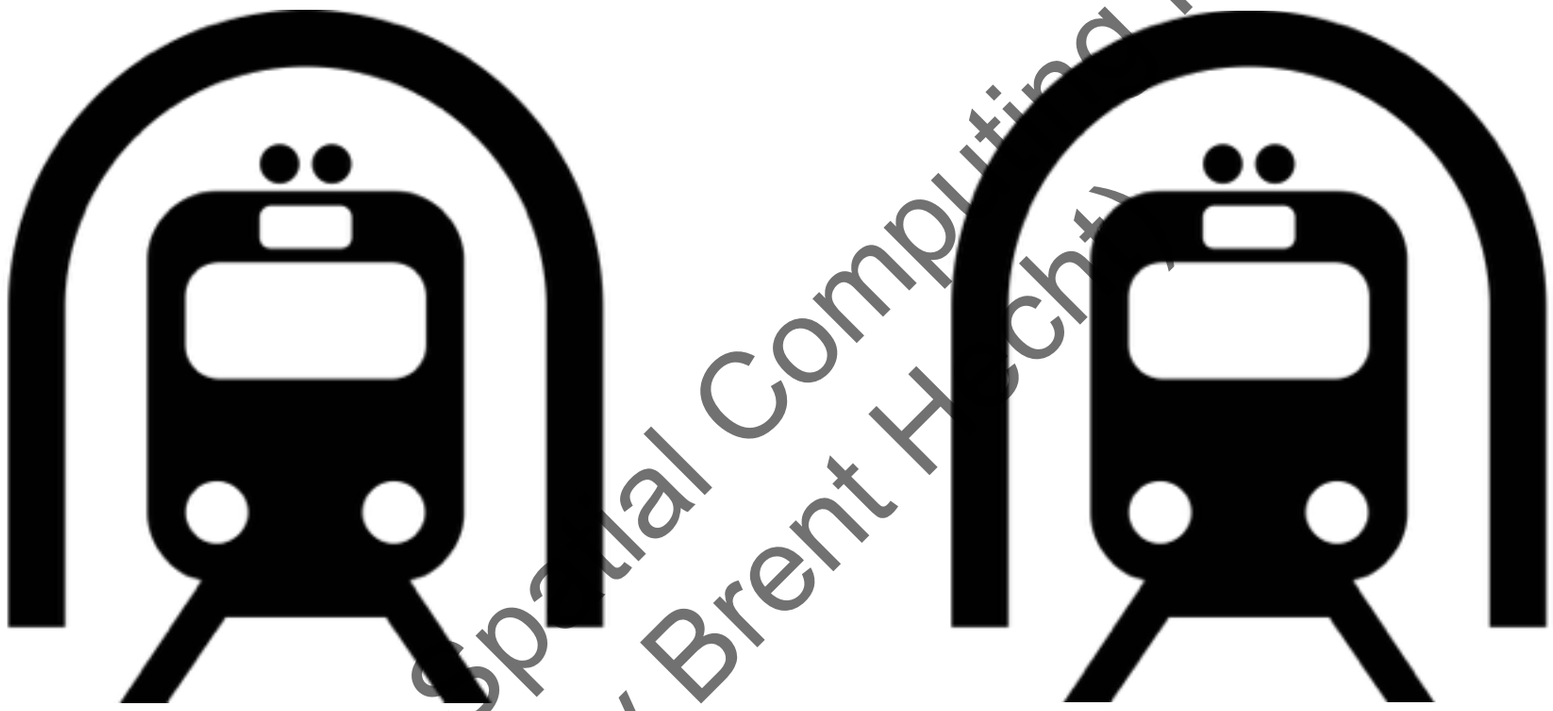
Cell

Internet

$€¥£



Smartphone



Not Moving

Moving

Apple - iPhone 5s - Technic...

Apple Inc. (US) https://www.apple.com/iphone-5s/specs/

Google

Power and Battery[6]

Built-in rechargeable lithium-ion battery

Charging via USB to computer system or power adapter

Talk time: Up to 10 hours on 3G

Standby time: Up to 250 hours

Internet use: Up to 8 hours on 3G, up to 10 hours on LTE, up to 10 hours on Wi-F

Video playback: Up to 10 hours

Audio playback: Up to 40 hours

Sensors

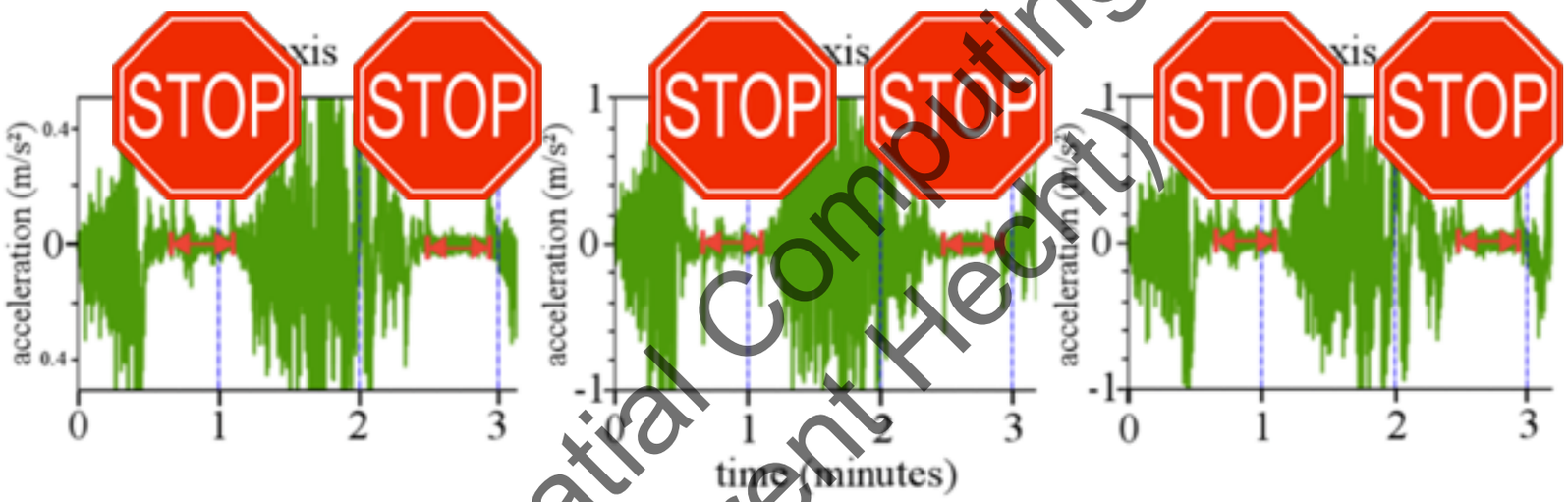
Touch ID

Three-axis gyro

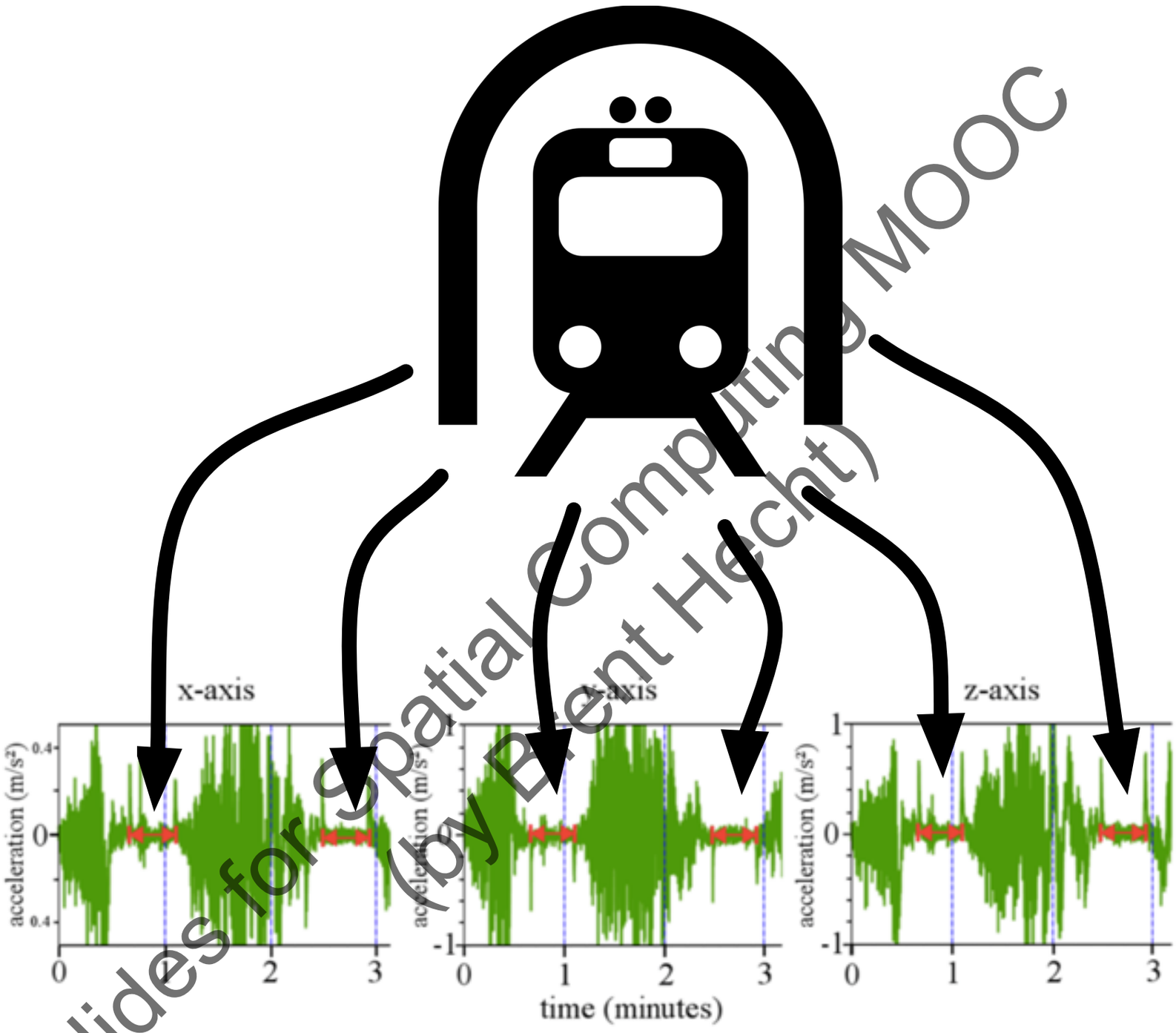
Accelerometer

Proximity senso

Ambient light sensor



Accelerometer readings from the Central Line in London



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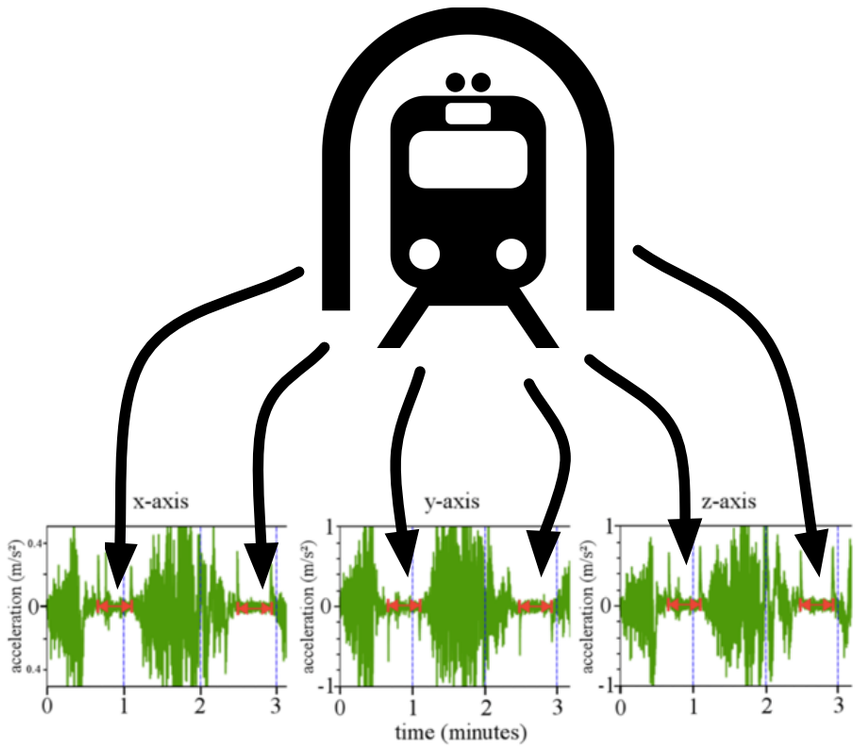


Stop Detection

: Vincennes

art	Dernier départ
	1:15
	1:13
	1:12
	1:10
	1:08
	1:07
	1:05
	1:03
	1:01
	1:00
	0:59
	0:57

Direction : Étoile

Premier départ	Dernier départ
5:30	0:42
5:31	0:43
5:32	0:44
5:33	0:45
5:34	0:46
5:35	0:47
5:37	0:49
5:38	0:50
5:39	0:51
5:40	0:52
5:41	0:53
5:43	0:55

M 6
Étoile
Nation

Nation
Picpus
Bel Air
Daumesnil
Dugommie
Bercy
Quai de la
Chevaleret
Nationale
Place d'Ital
Corvisart
Glacière

Official Timetable

Smartphone Position

along a subway line

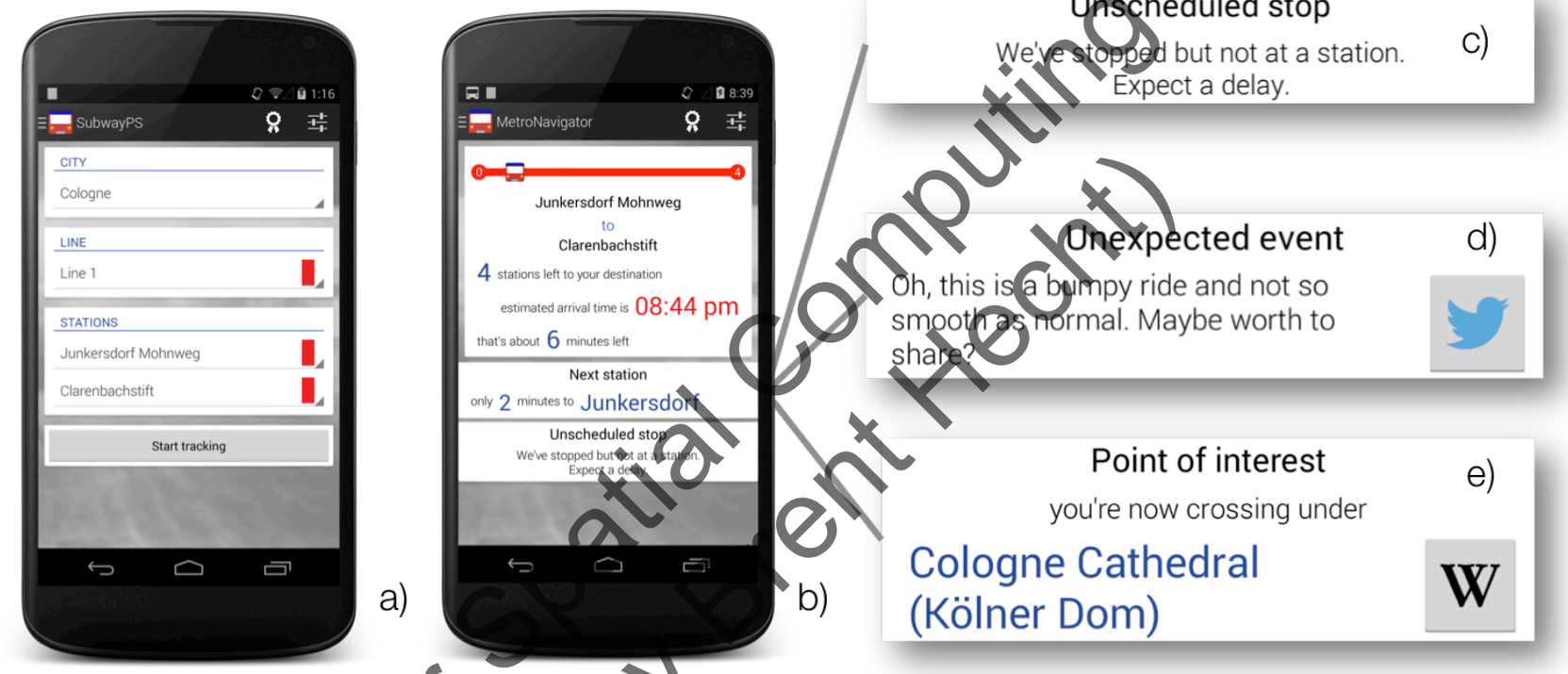
Stop Detection:

85% **accurate** across four subway systems

Whole Trip Accuracy:

78% of trips tracked **perfectly**

42% baseline of using **timetable only**



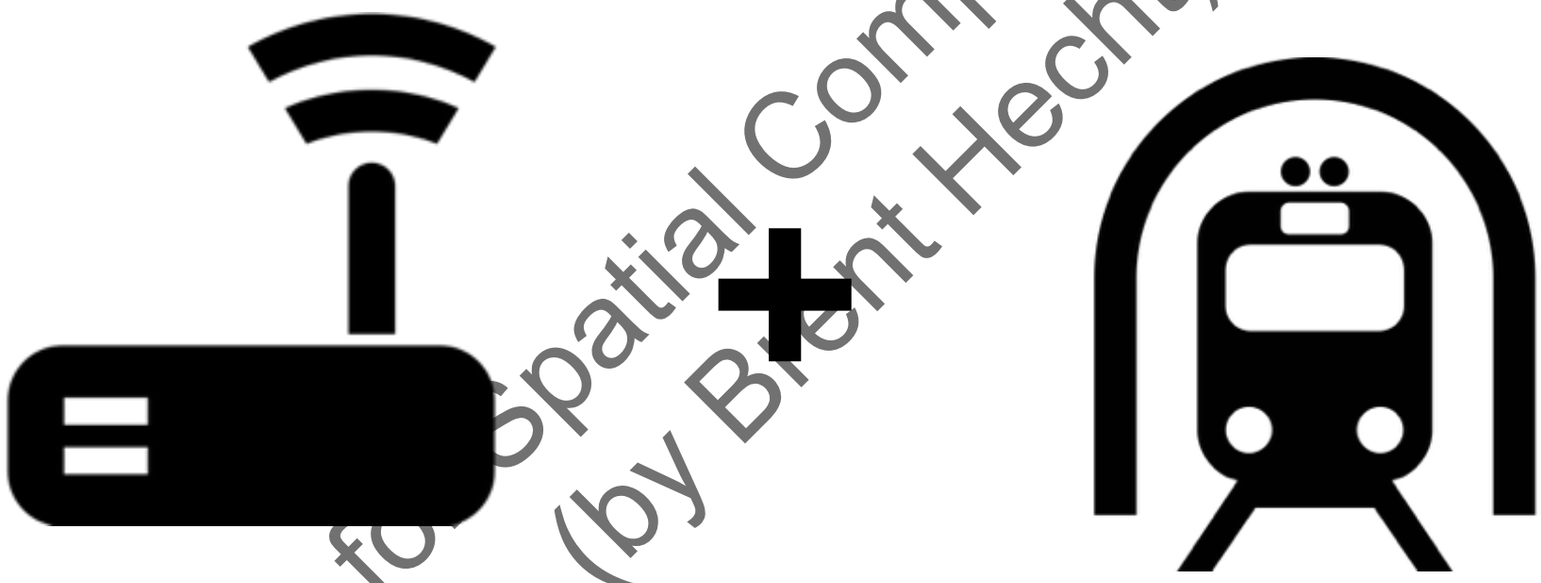
MetroNavigator

As my GPS does not work here, this is like a GPS for undergrounds trains – I want to have it integrated in Google Maps" (Participant 3)

"*It is just cool to see the train moving and stopping on the map – I feel safer when I can see that we have stopped close to the next station when we're stopped in the middle of a tunnel*" (Participant 11)

Oops, it seems that the system missed a stop – that is not good. I would also be happy to help the system to detect the stops, if the system could help me to get out at the right station. That would be totally fine with me." (Participant 3)

Future Work



Correcting for drift errors

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