

# Mobile App Development for Research

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# About Me

- Bsc, MPhil. Computer Science, Tongji University, China
- PhD. Computing, The HK Polytechnic University, Hong Kong
- 2007 — 2017. Lecturer, Tongji University, China
- 2017.5 — Current, CeR, VM team.



# Complete Syllabus

- Mobile Application Platform
- Android Basics
- Development Environment
- Hello World Android!
- User Interface
- Data Storage
- Networking and Communication
- Graphics and Multimedia
- Sensors
- Advanced Topics

# Recommended MOOC

Android and iOS courses on **Udacity**

# Outline

Part 1: Fundamentals

Part 2: Sensors

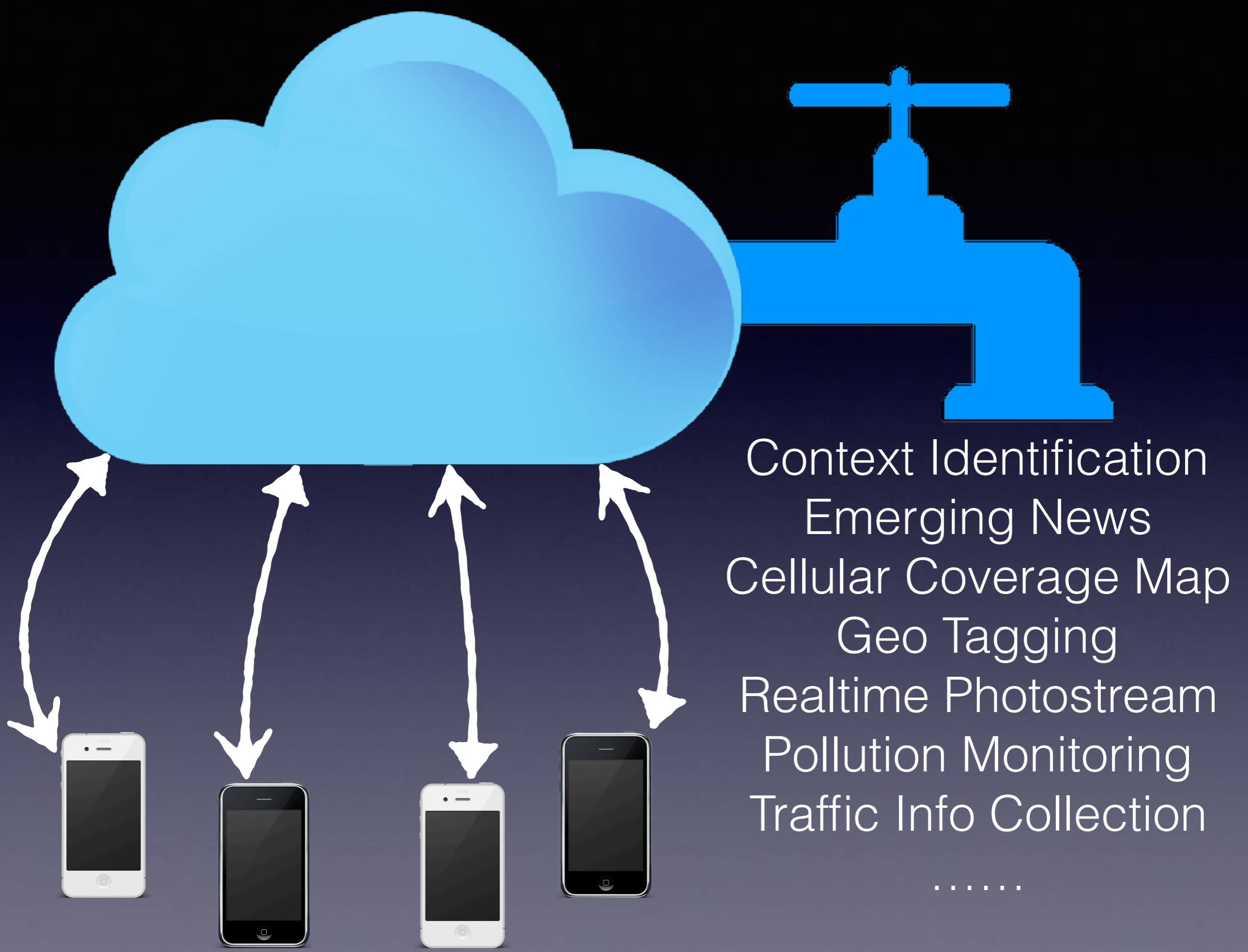
Source code & slides:

<https://github.com/cszhe/app4r>

How can we utilise  
smartphones in research?

A large, stylized lowercase letter 'a' with a black outline and a white fill. It is overlaid on a circular teal sticker containing various numbers and letters. The sticker includes the following text:

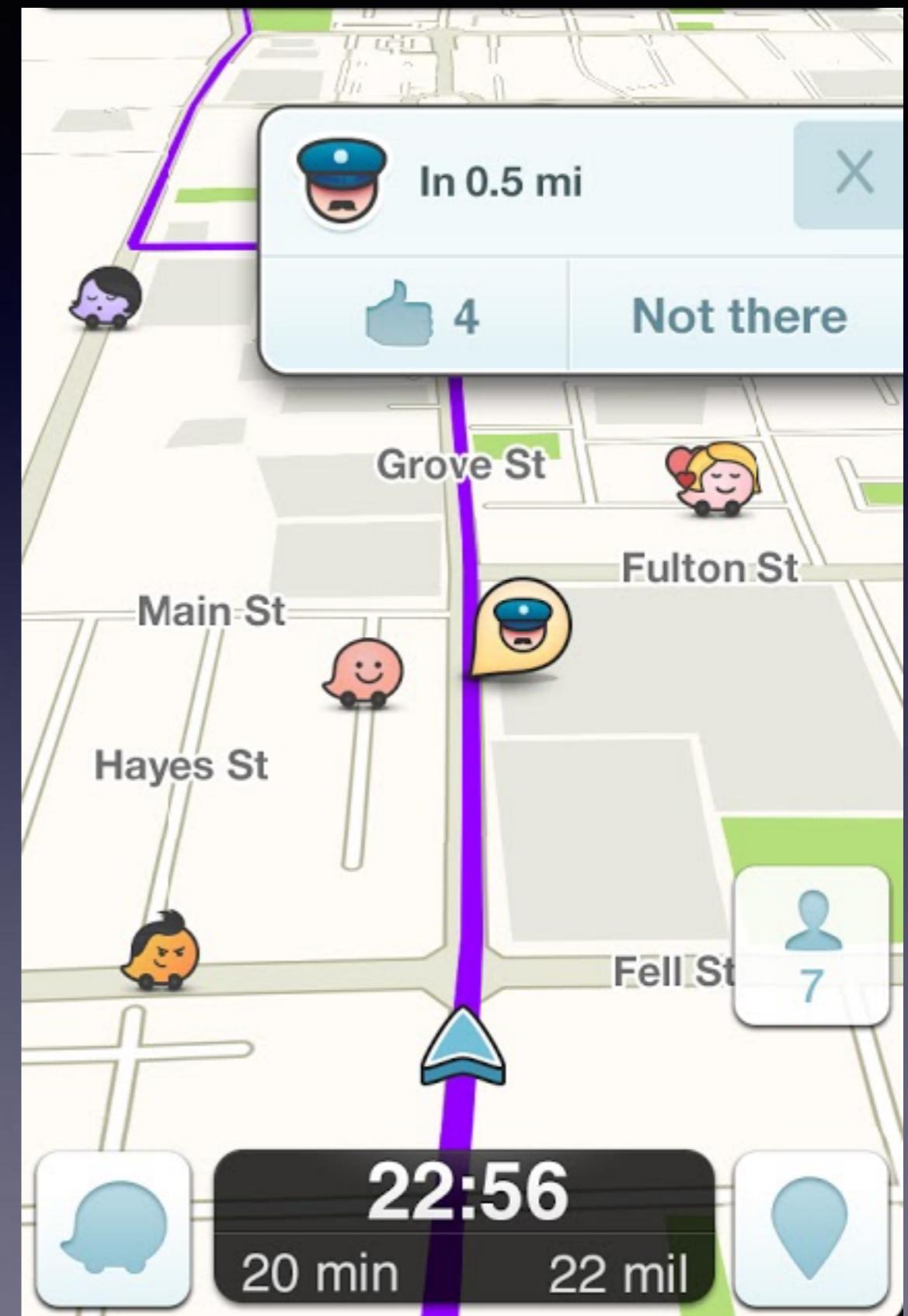
AD4B0A7C A  
BF0  
ABC3A 2  
6  
67T6  
3A72A



# Traffic Info Collection



waze by Google



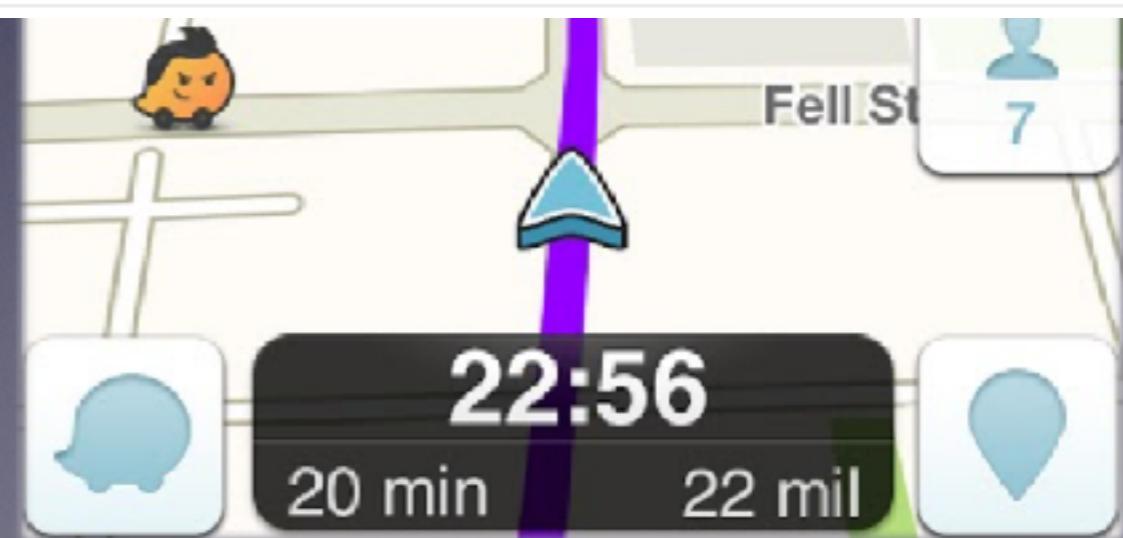
# Traffic Info Collection

CNET › Tech Culture › Cops accused of fiddling with their locations on Waze to fool drivers

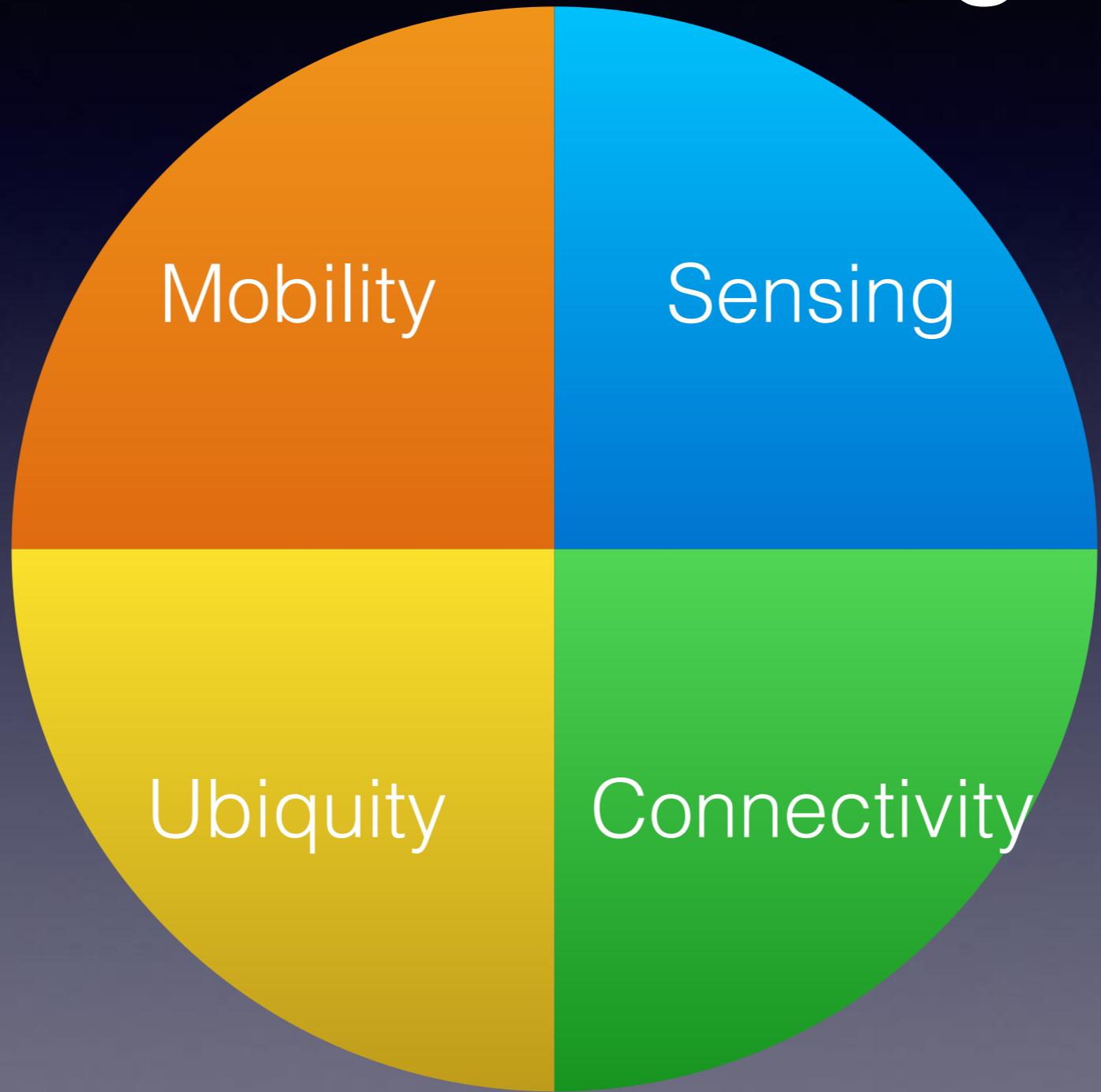
## Miami Cops Flood Waze With Bogus Speed Trap Data, Don't Understand How Crowd Sourcing Works

by **Chris Matyszczyk** @ChrisMatyszczyk / February 12, 2015 4:19 PM PST

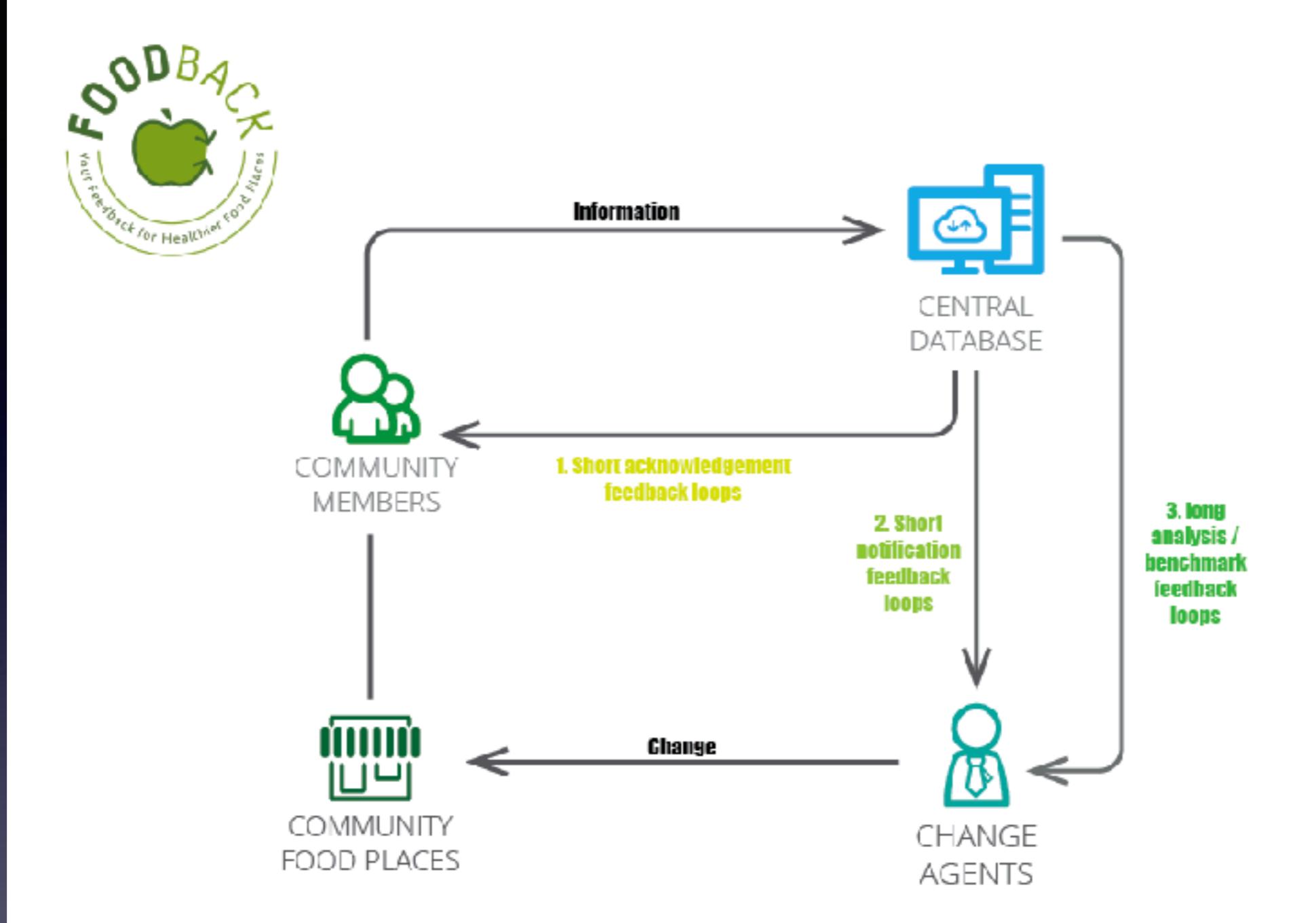
waze by Google



# Smartphone based Crowdsourcing



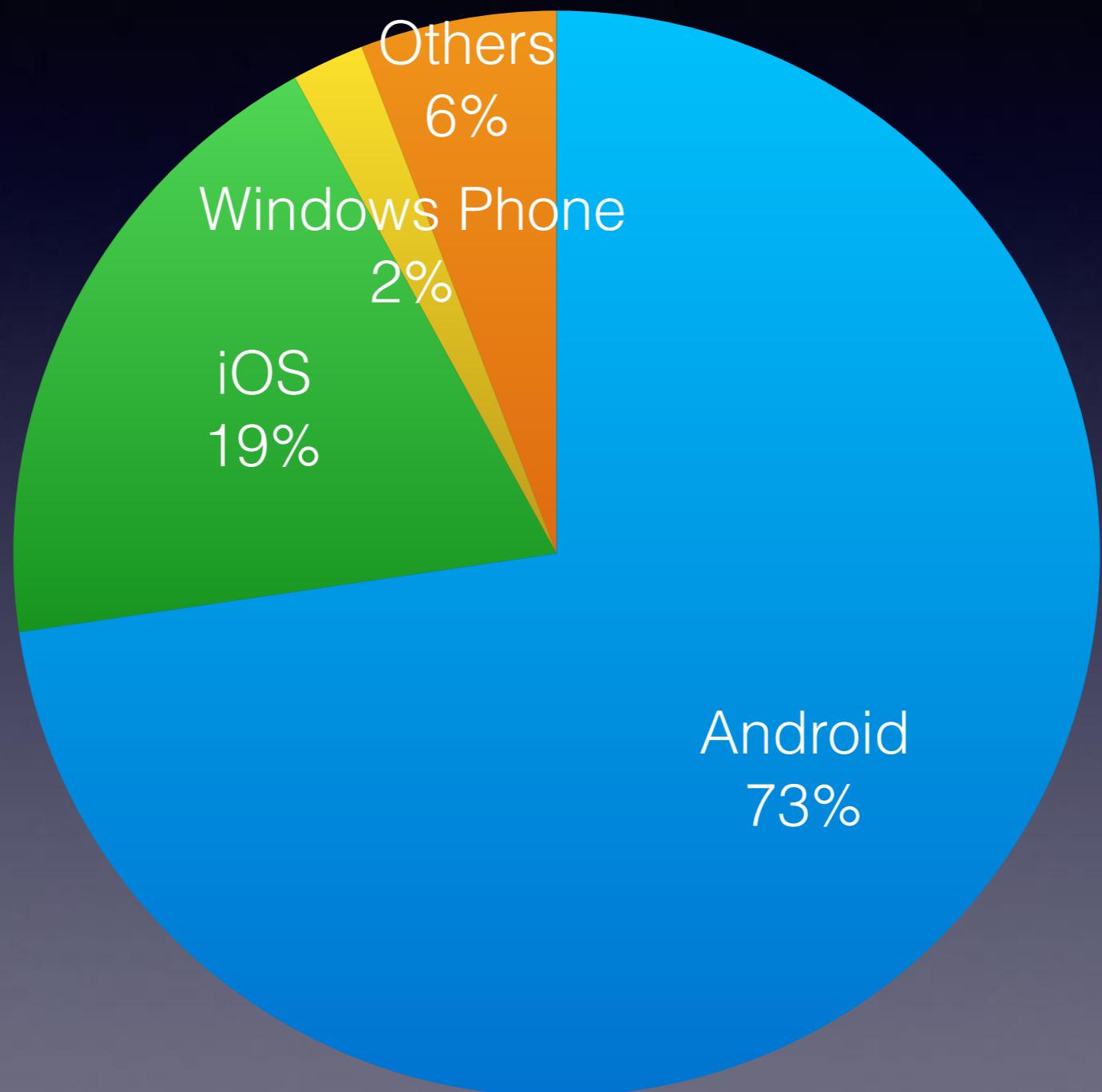
# Case Study



Website: <http://www.foodback.org.nz/>

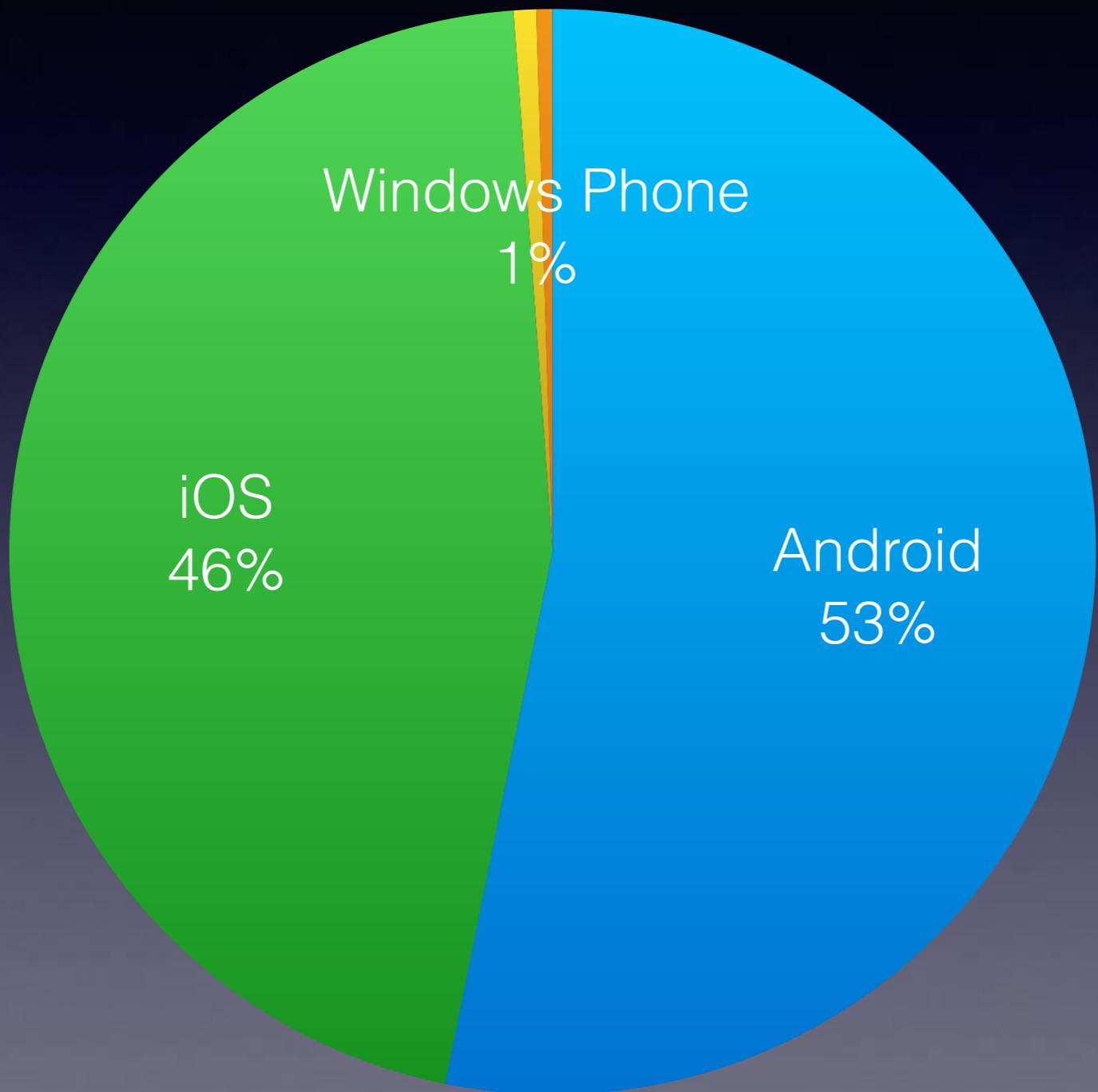
Introduction: <https://youtu.be/-4gUui0DWLA>

# Market Share — Worldwide



Source : statcounter, May 2017

# Market Share — NZ

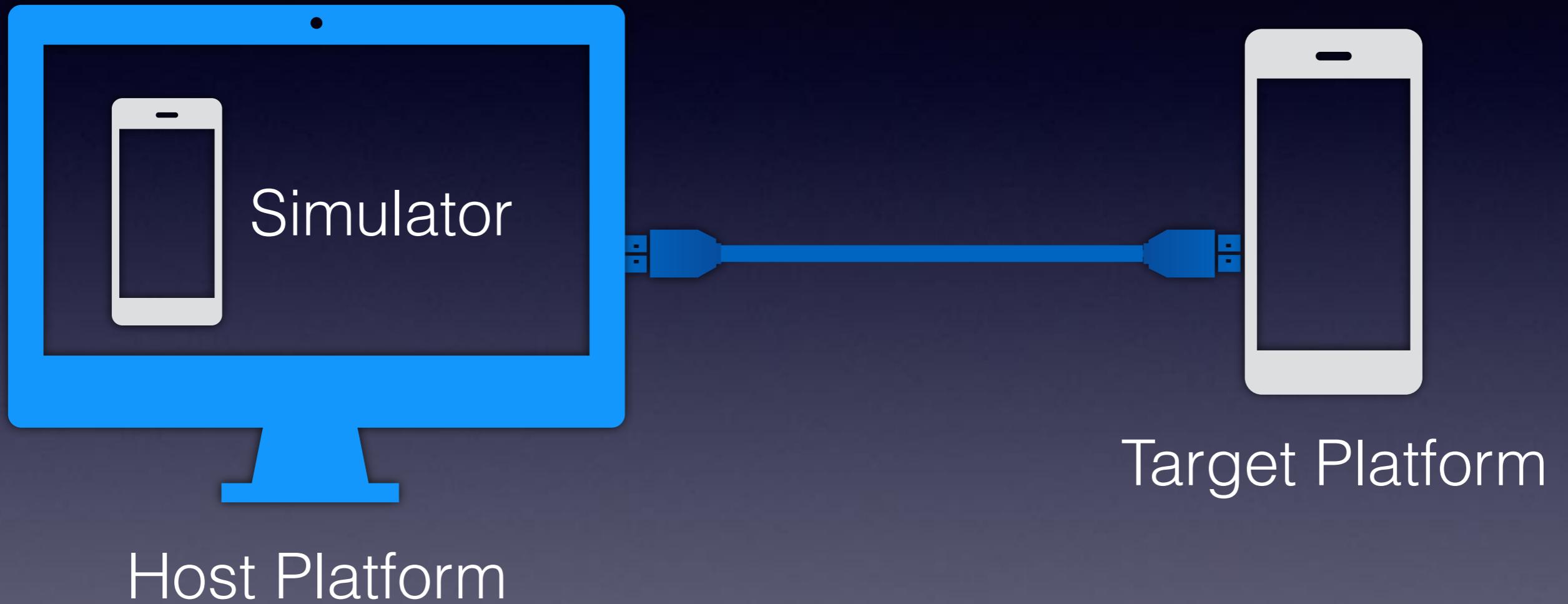


Source : statcounter, May 2017

# Mobile Dev Key Features

1. Cross Platform Development
2. Energy Efficiency

# Cross Platform Development



# Dev Platform (Official)

Target Platform	Programming Language	IDE	Host Platform
Android	Java, Kotlin (SDK) C / C++ (NDK)	Android Studio	Windows / macOS / Linux
iOS	Objective C / Swift	XCode	macOS

# Dev Platform (Unofficial)

	Programming Language	IDE	Target Platform
Xamarin	C#	Visual Studio	Android, iOS, Windows Phone Native
phonegap / cordova	HTML5 / JS / CSS	Any Text Editor	Browser + Extension

# Demo: Hello World

# Energy Efficiency

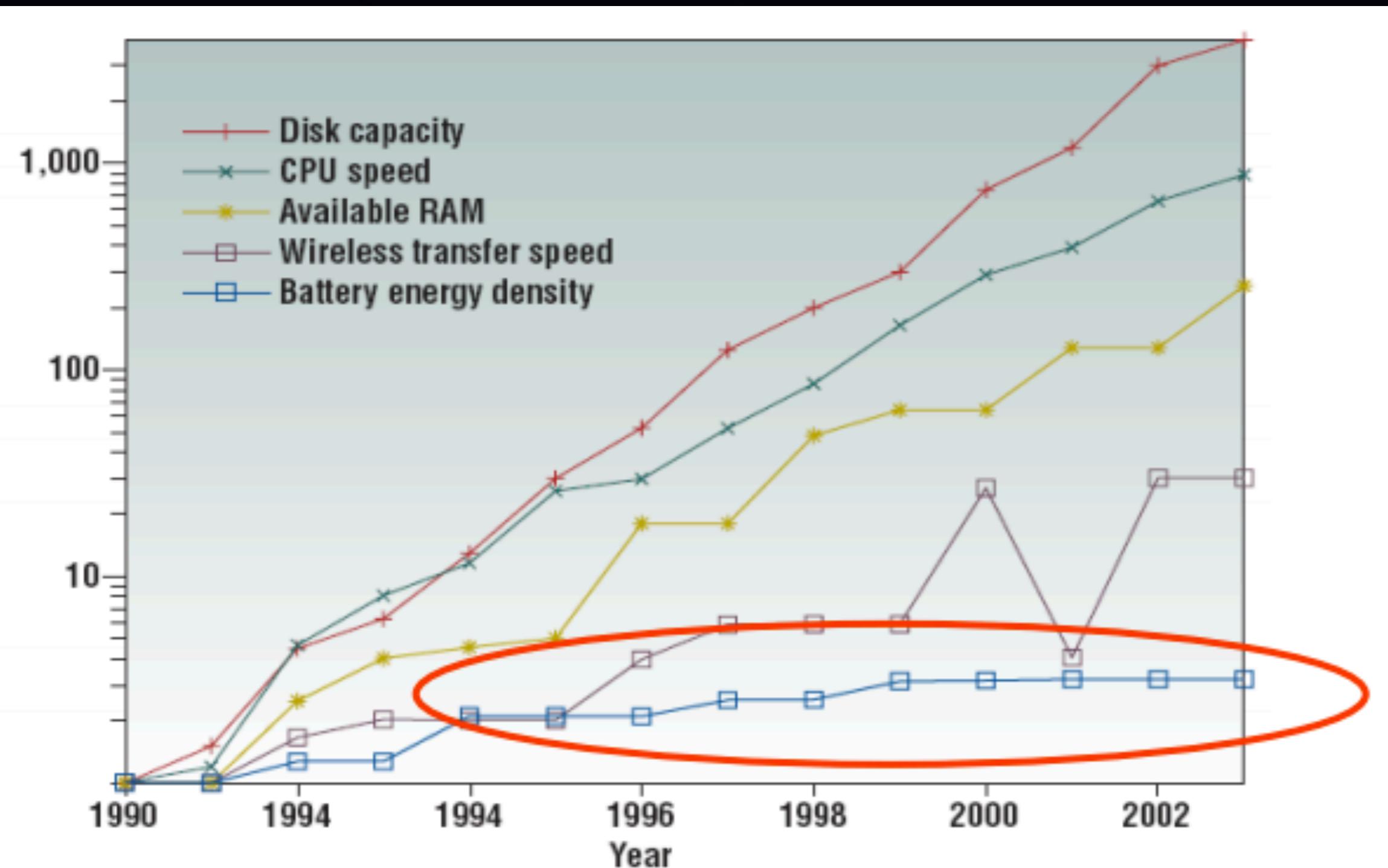


MacBook



iPhone 7 Plus

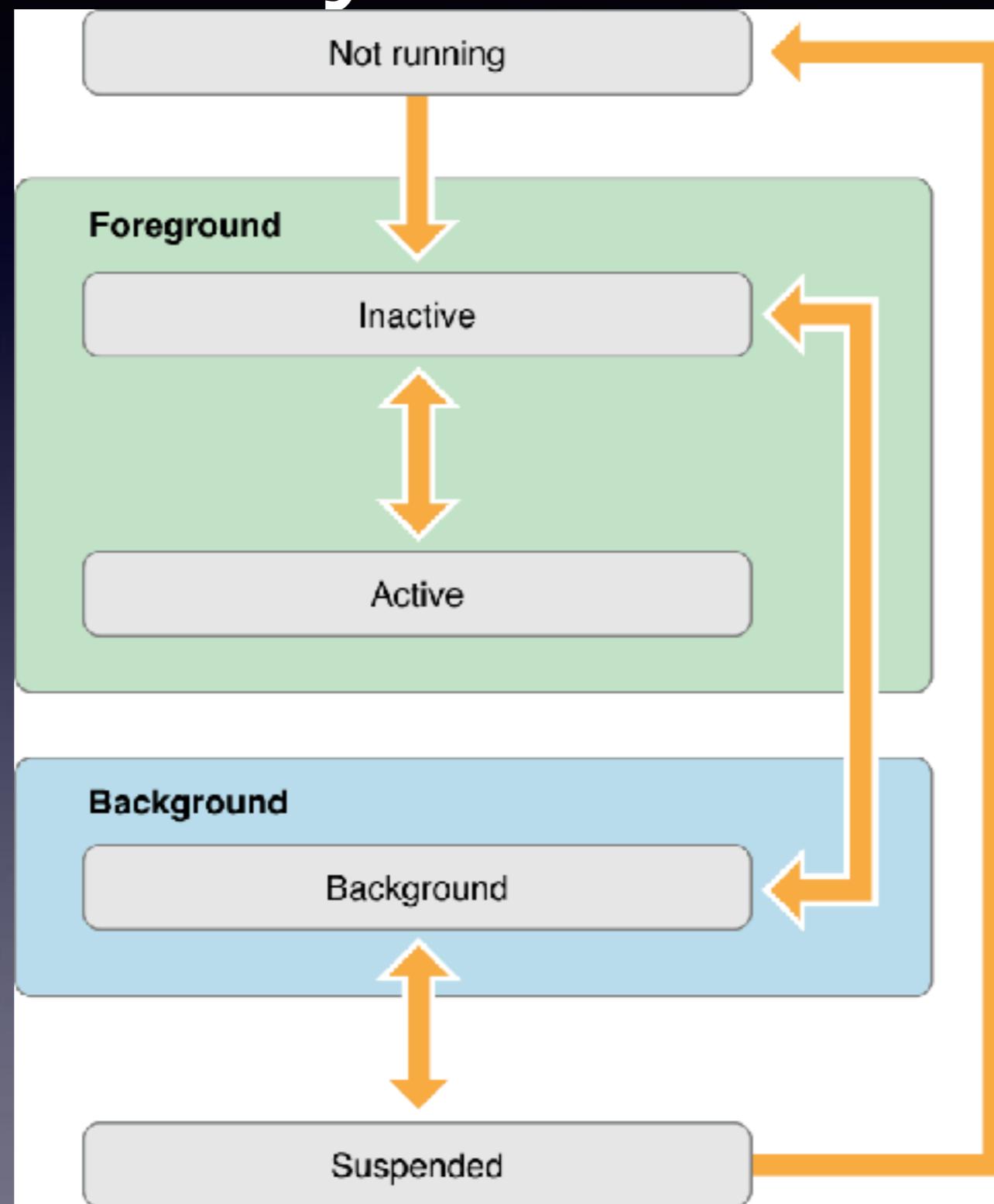
# Energy Efficiency



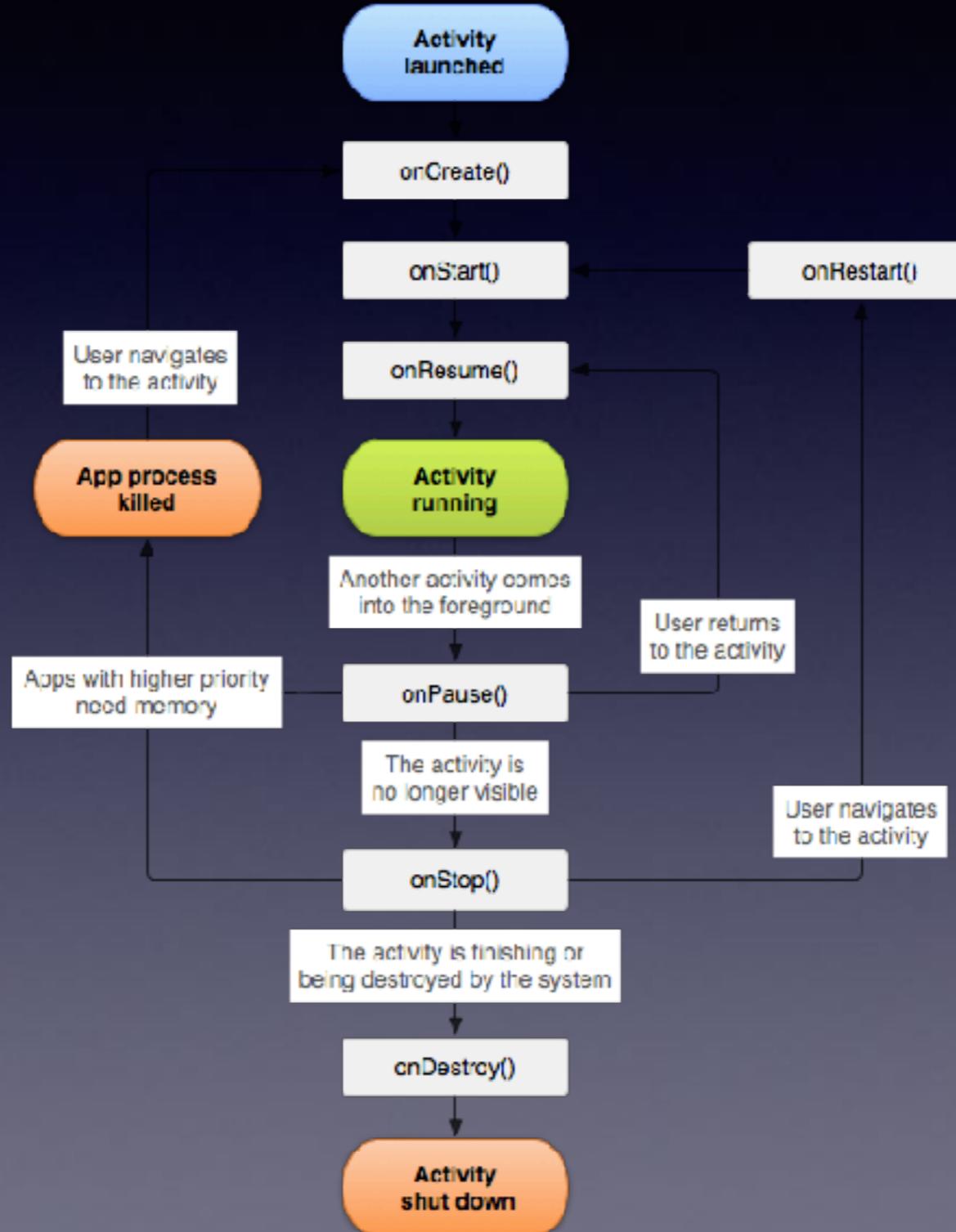
# Energy Efficiency in App

- Respond to hardware events:
  - Screen on / off
  - Power connected / disconnected
- Limited multi-tasking support in OS:
  - Switch between foreground and background
  - Suspend / Resume

# Life Cycle — iOS



# Life Cycle — Android



# BG Execution — Guideline

iOS

Android

Guideline

Guideline

# Demo: App Life Cycle

# App Distribution — Official

	Android	iOS
Store	Google Play Store	App Store
Price	\$25 one time	\$99 / year
Review Process	Loose	Strict
Time to market	Fast	Slow

Follow the checklist: [iOS](#) [Android](#)

# App Distribution — Unofficial

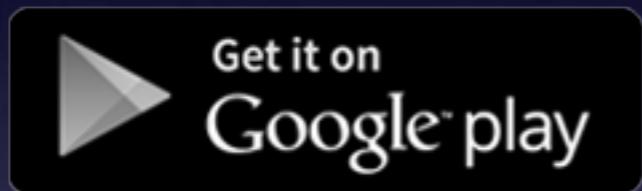
	Android	iOS
Direct Install	Turn off unidentified developer option	Jailbreak
Source code Distribution	Install Android SDK	Install Xcode

# Sensors

- Sensors have changed the phone industry.
  - One of the key feature of smartphone.
  - Enabling technology for:
    - Augmented Reality
    - Innovative HCI
    - Context-aware Applications



# Learning Sensor Data



Sensors Multitool

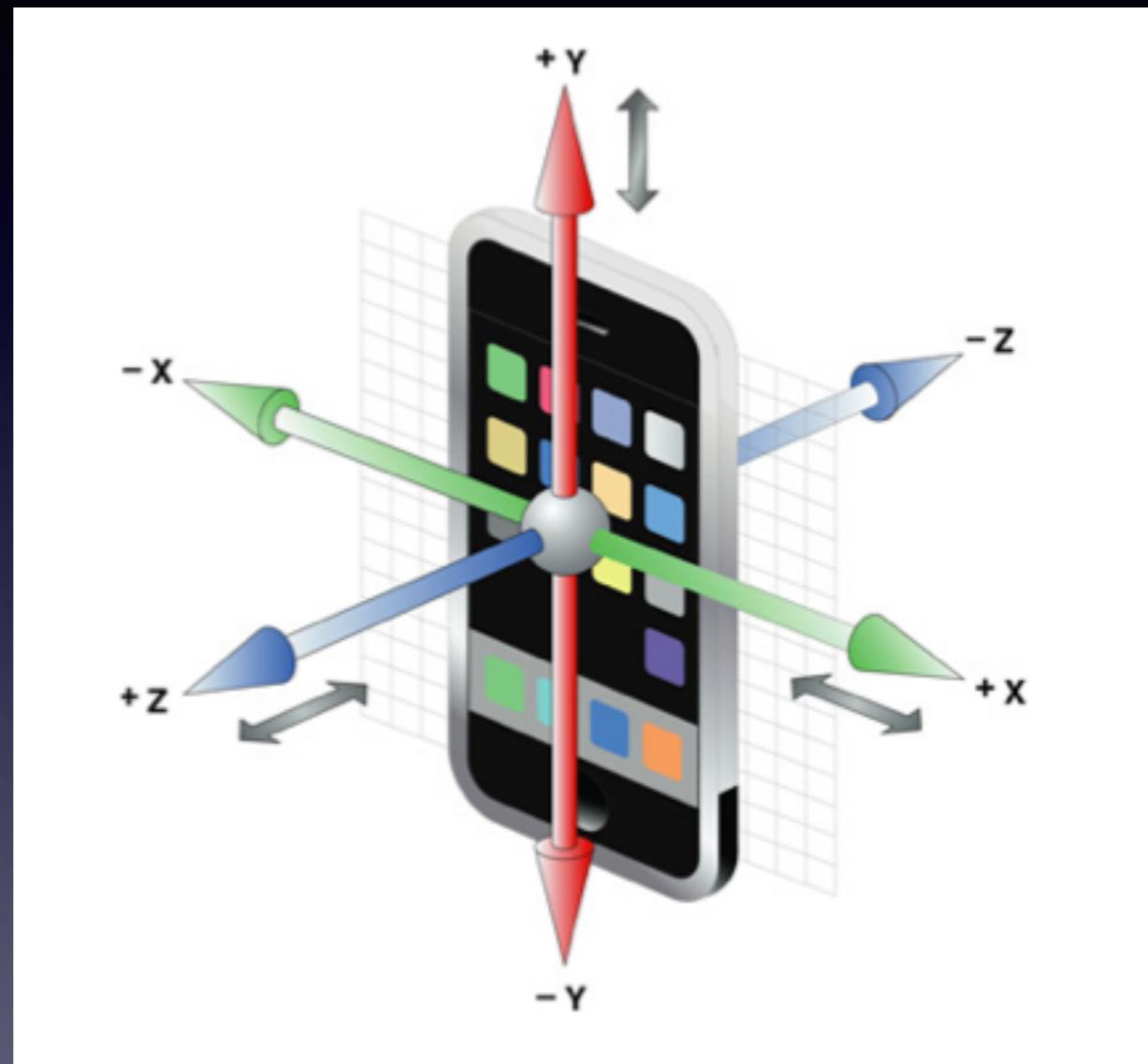


SensorKinetics

# Accelerometer

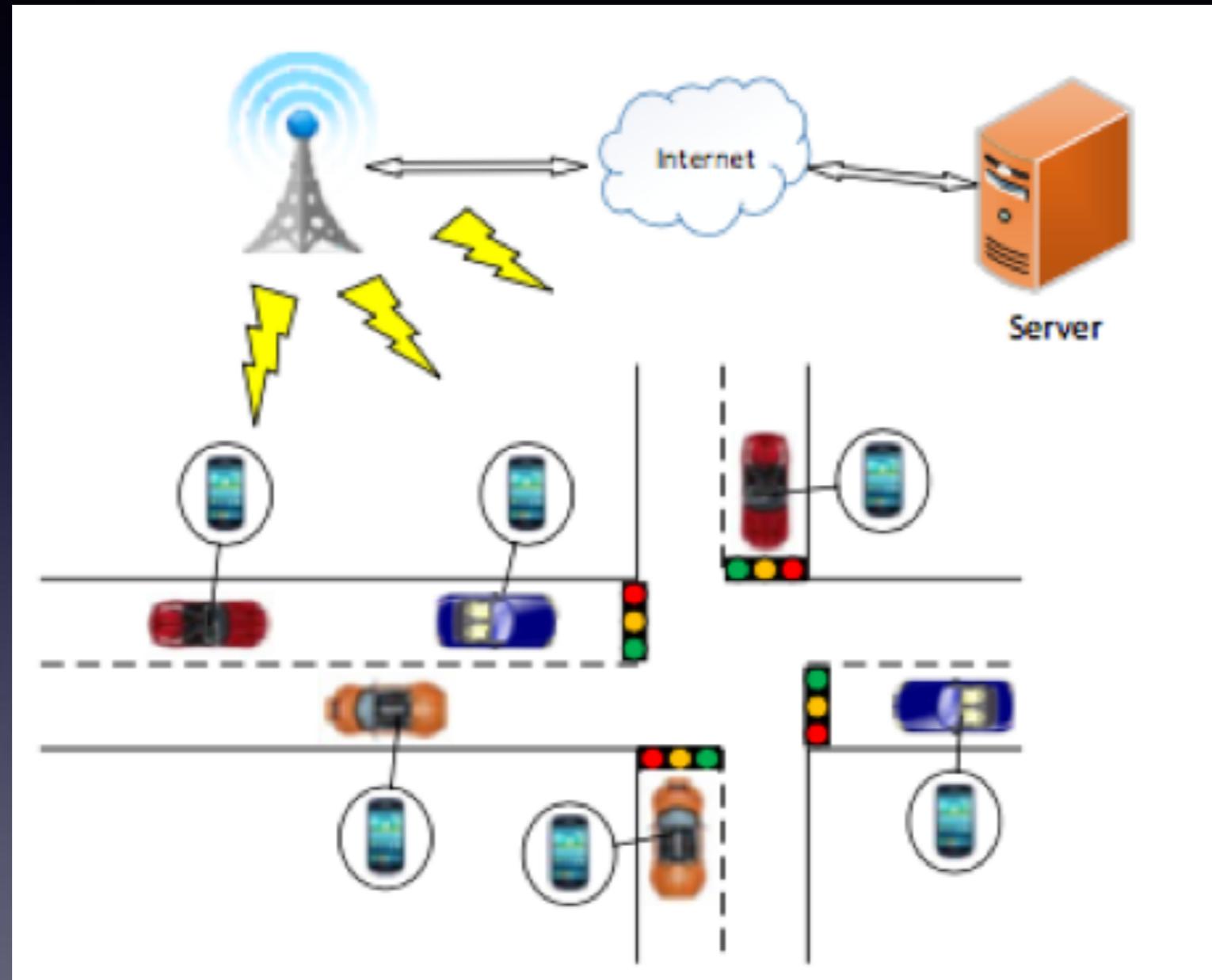
- Measures proper **acceleration** (acceleration it experiences relative to **freefall**), felt by people or objects
- Units: m/s<sup>2</sup> or g
- Most smartphone accelerometers trade large value range for high precision, iPhone range:  $\pm 2g$ , precision 0.018g
- Sample Applications:
  - Screen rotation
  - Free fall detection
  - Phone tap detection
  - Human behaviour detection

# Axis



Phone frame <→ Earth frame

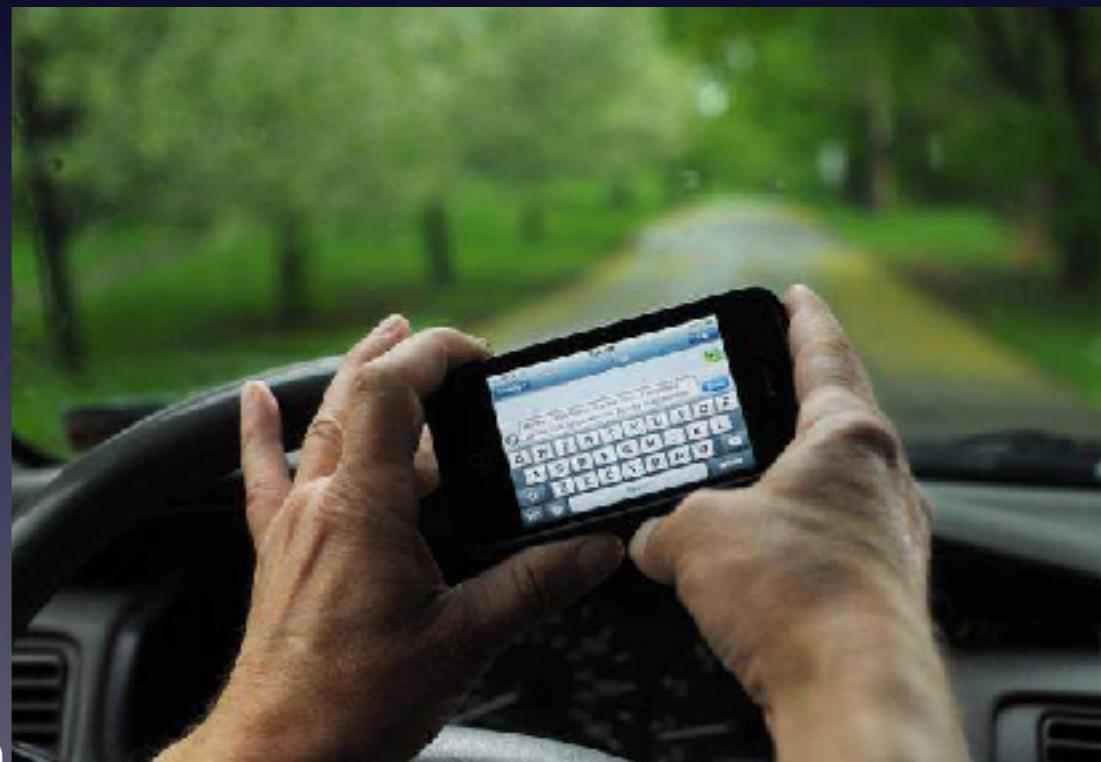
# iTip: traffic signal prediction



Junhao Zheng, Zongjian He, et al. iTrip: Traffic Signal Prediction using Smartphone based Community Sensing. The 17th International IEEE Conference on Intelligent Transportation Systems (ITSC 2014)

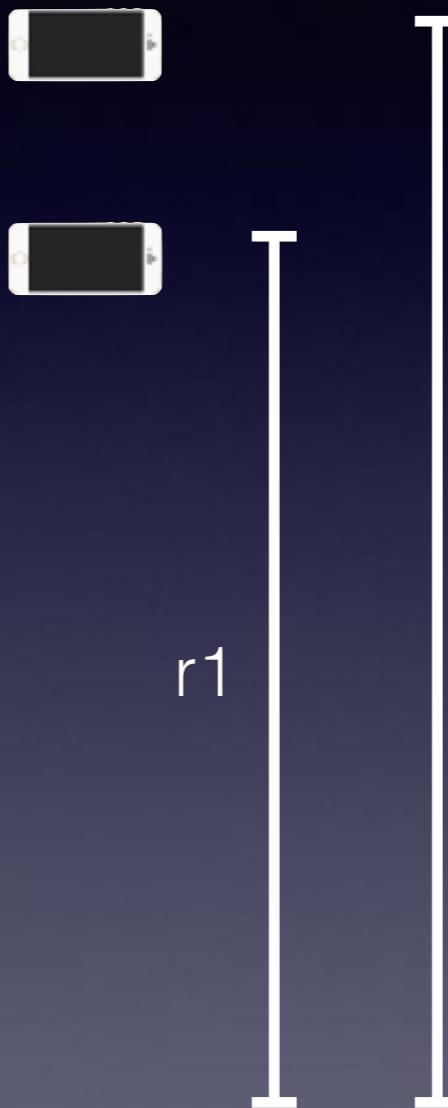
# iLOC

- Fine-grained in-vehicle positioning can improve many vehicular applications
  - Accuracy
  - User experience
- Examples:
  - Drowsiness detection
  - Driver distraction reduction
  - Automatic profile switching



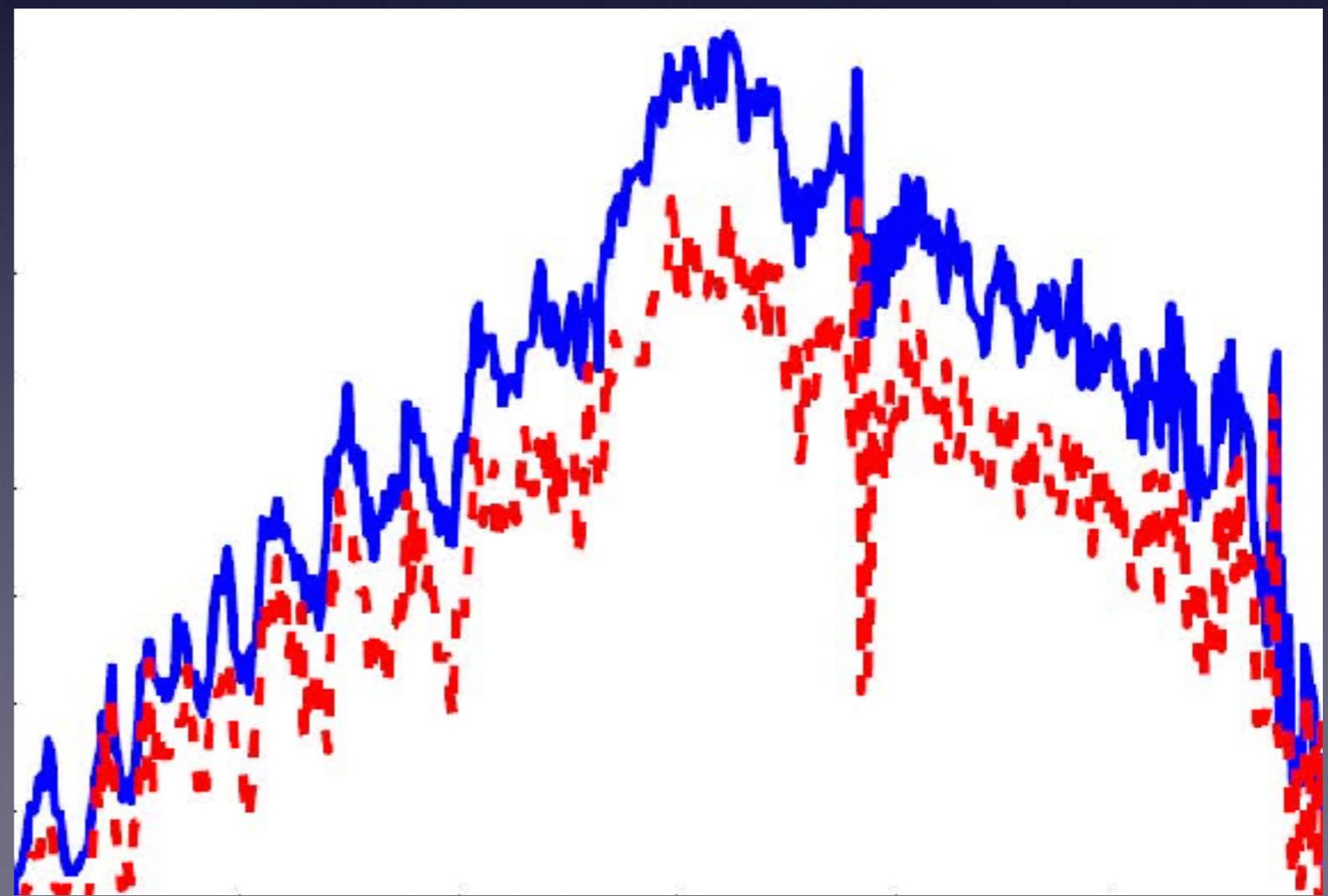
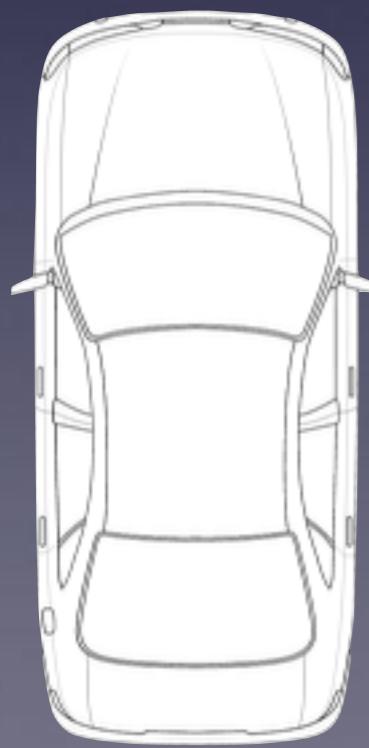
Zongjian He, Jiannong Cao, et al. Who Sits Where? Infrastructure-Free In-Vehicle Cooperative Positioning via Smartphones. Sensors. 2014

# How

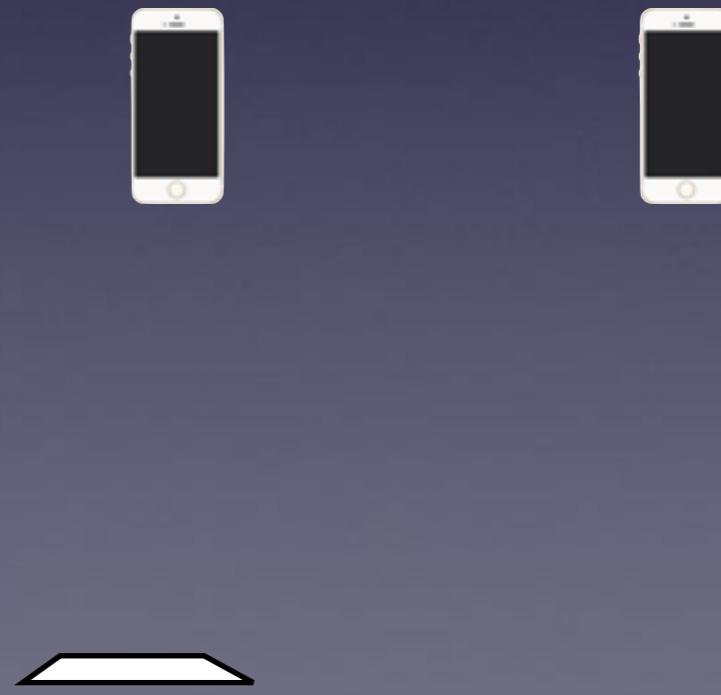
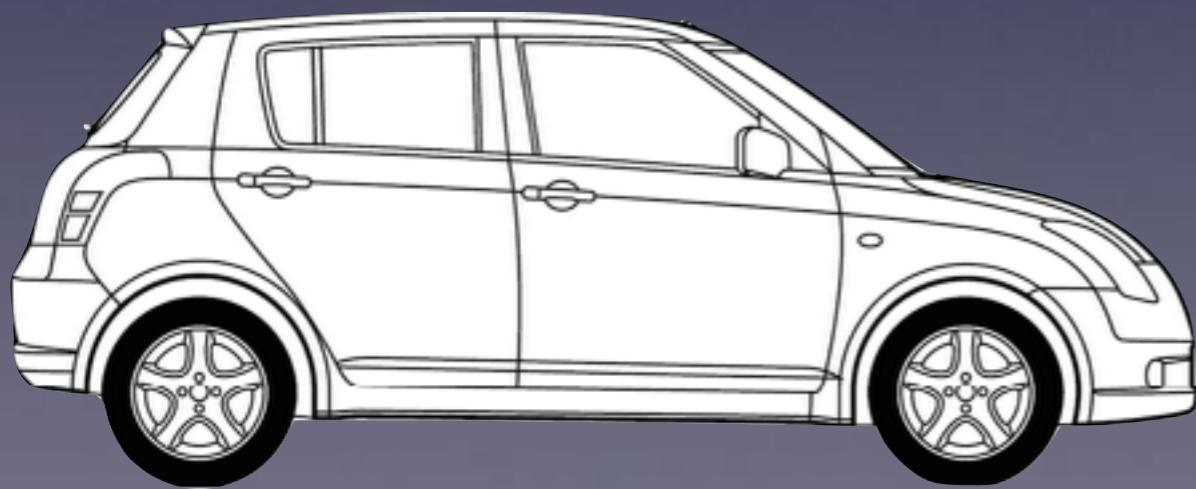
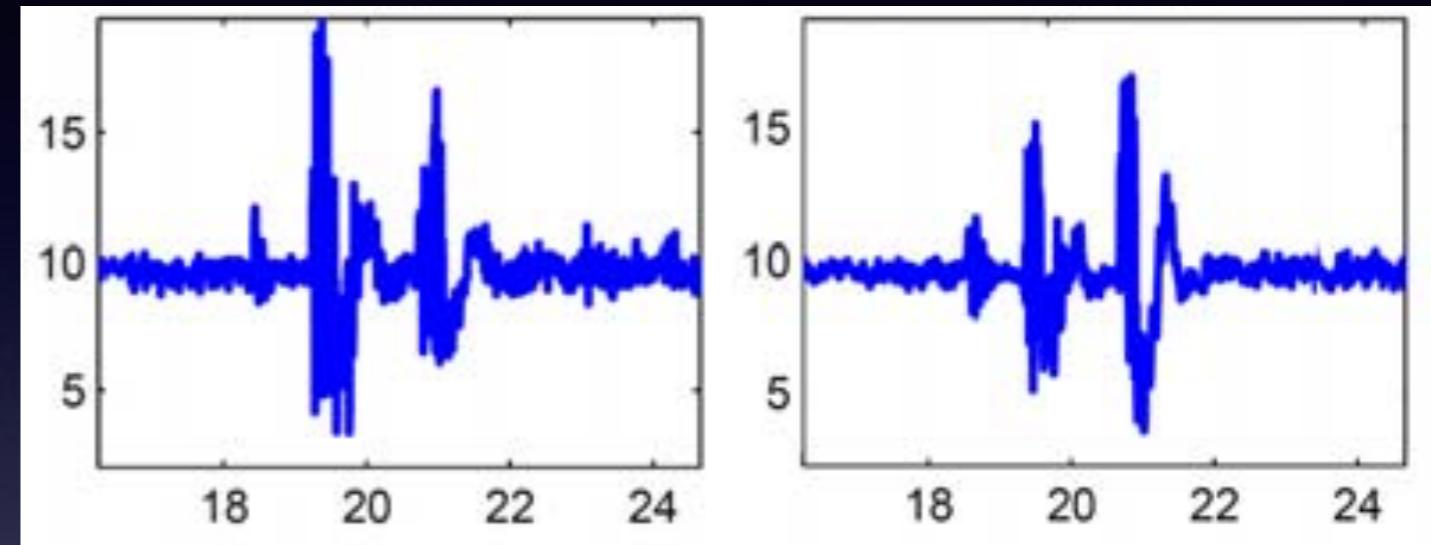


$$a_c = \omega^2 r$$

# Left / Right Identification



# Front / Back Identification



# Gyroscope

- Detects the **changes** in the orientation
- Unit: rad / s
- Orientation can be computed from the angular rate that is detected by the gyroscope
- Sample apps:
  - AR games
  - Rotation detection

# Texting & Driving Detection

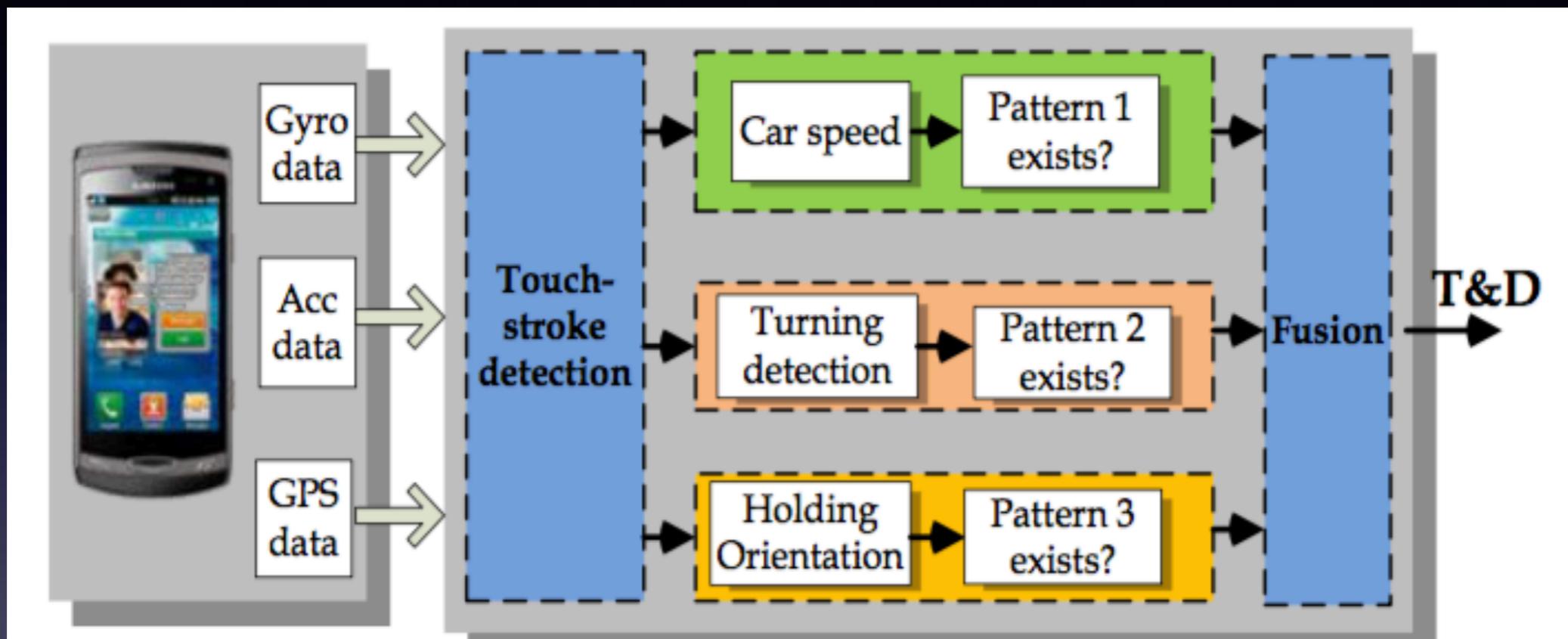
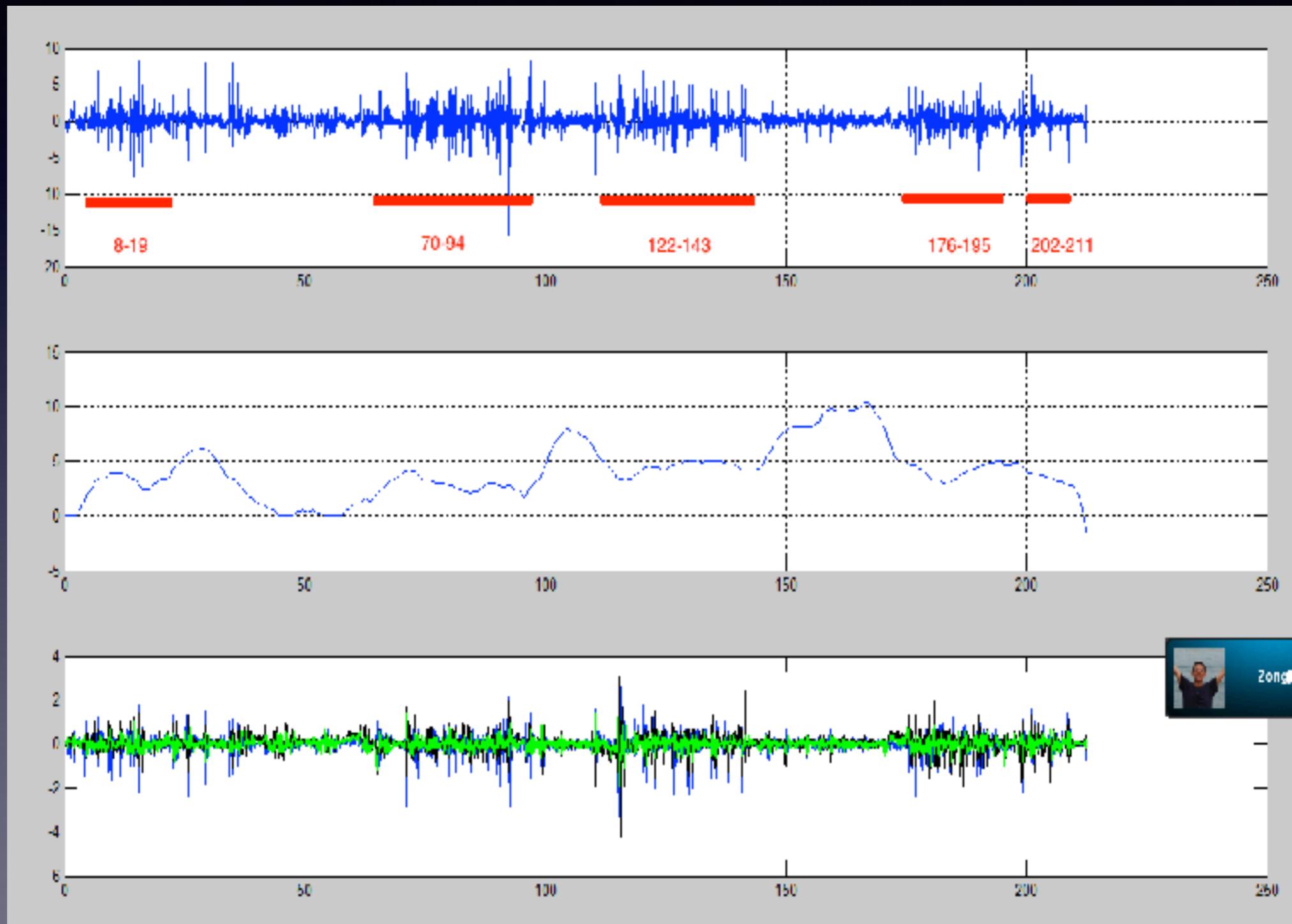


Fig. 1: The logic flow of the T&D system

Xuefeng Liu, Jiannong Cao, Shaojie Tang, Zongjian He, Jiaqi Wen. Drive Now, Text Later: Nonintrusive Texting-while-Driving Detection using Smartphones. IEEE Transactions on Mobile Computing.

# Gyroscope --> keystroke



# Magnetometer

- Measures the strength of **earth's magnetic field**
- Strength is expressed in tesla [T]
- iPhone magnetometer range:  $\pm 2\text{mT}$
- Sample Apps:
  - Compass
  - Frame trans: phone frame -> earth frame.

# Proximity

- Detect how close between the phone and the body.
- Precision: boolean or length.
- Sample Apps:
  - Disable touch during phone call. (Introduced in first generation of iPhone)

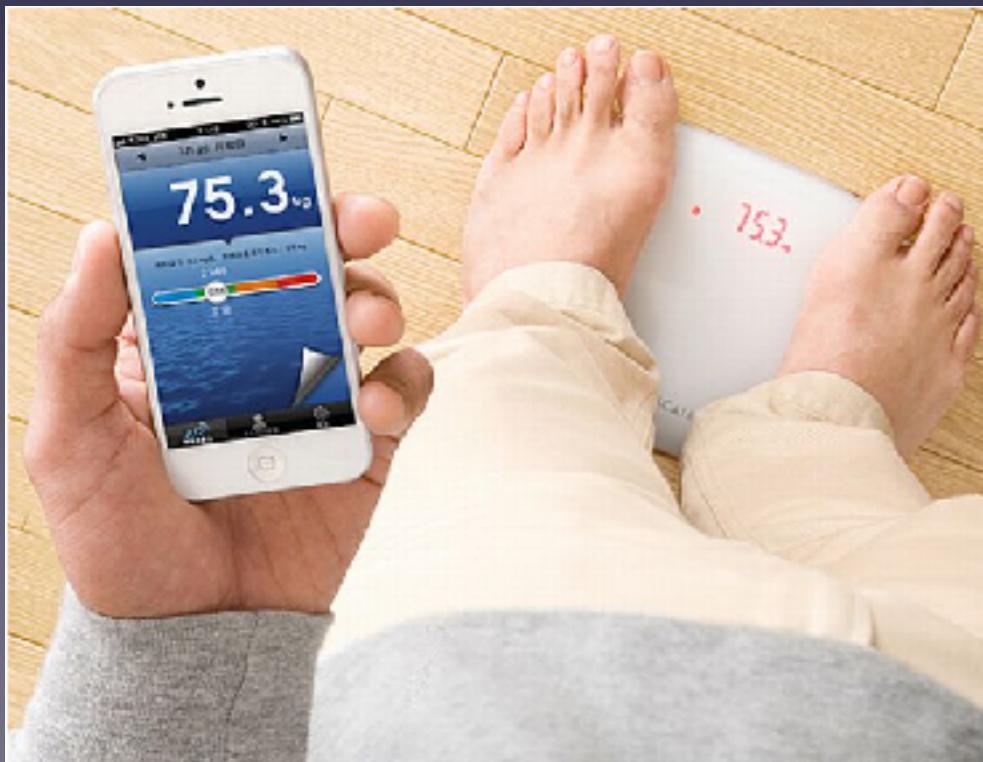
# Luxmeter

- A.k.a. : Ambient light sensor
- Detect the light of the strength
- Sample Applications:
  - Screen auto brightness

# barometer

- Measures atmospheric pressure
- Unit: hPa
- Sample applications:
  - Calculate altitude
  - Floors climbed

# External Sensors



# Are we missing something?

- Camera
- Microphone
- Wireless networks
- .....

# Camera

- Image Capture & Processing
- MIT researchers measure your pulse, detect heart abnormalities with smartphone camera
- Measuring heart rate with a smartphone camera
- App Store: Instant Heart Rate: Heart Rate & Pulse Monitor

Cellular Tower

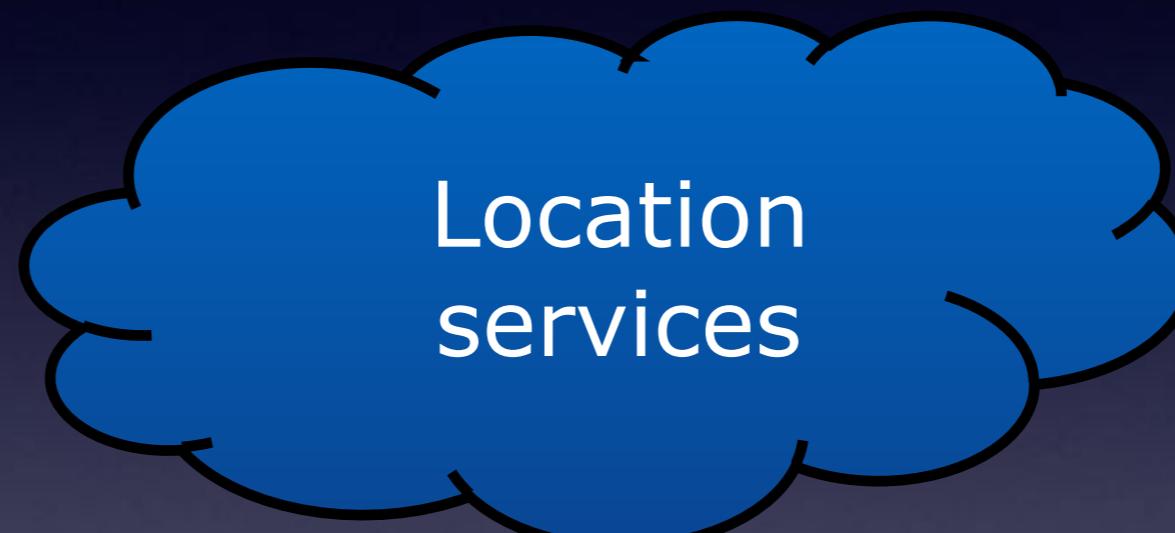


- Accuracy
- + Power
- + Speed
- Wilderness



GPS

- + Accuracy
- Power
- Speed
- Indoors



- +/- Accuracy
- +/- Power
- +/- Speed
- +/- Urban areas



WiFi

# Wireless Networks

- RSSI: Received Signal Strength Indicator
- Indoor Localisation
- Respiration Monitoring
  - Contactless Respiration Monitoring Via Off-the-Shelf WiFi Devices
- Activity & Gesture Recognition
  - The telepathic phone: Frictionless activity recognition from WiFi-RSSI

# Other Sensors

- Temperature
  - Crowdsourcing urban air temperatures from smartphone battery temperatures.
- Microphone
  - Ear-phone: an end-to-end participatory urban noise mapping system

# Demo: Sensors

# References

- Android and iOS courses on Udacity
- Android Developer Website
- iOS Developer Website

Thank you !