

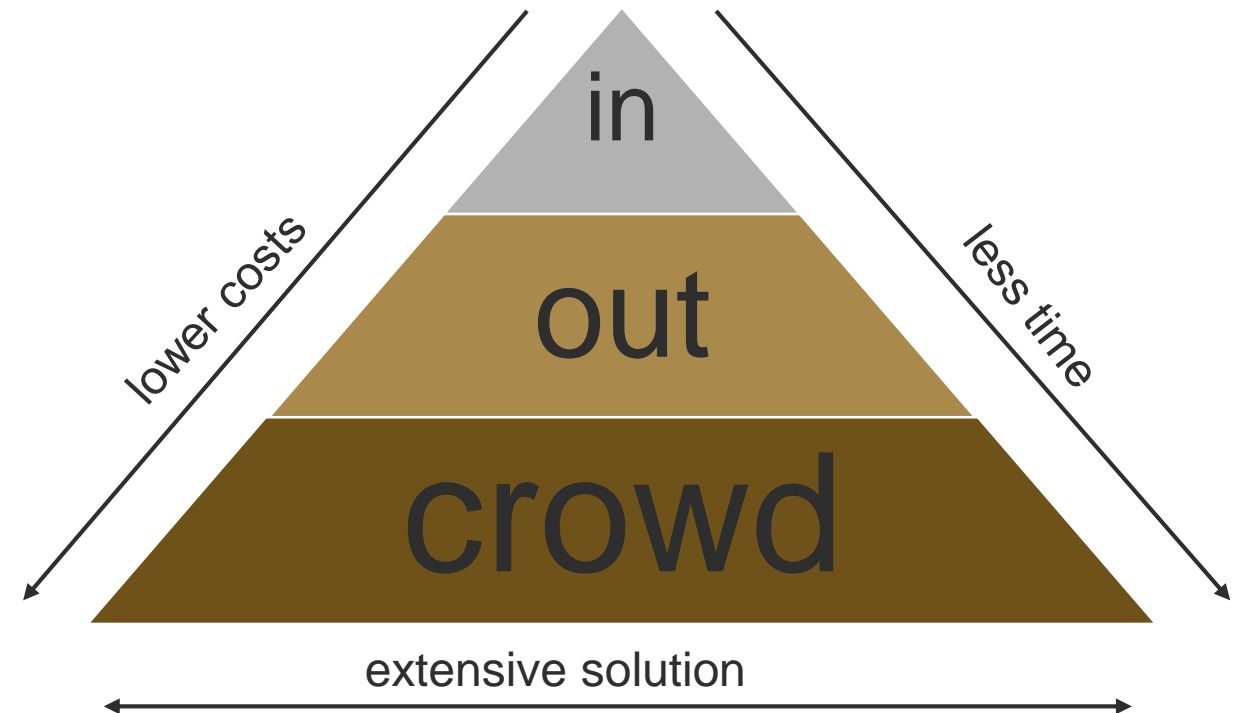


Sensor networks and applications

Crowdsensing

Crowdsourcing

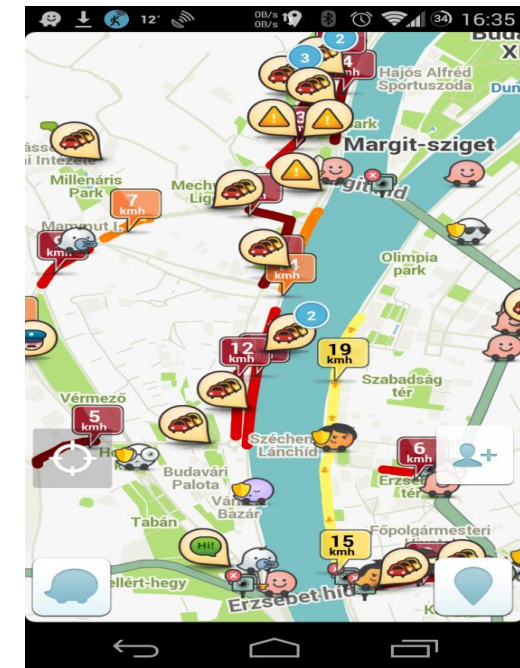
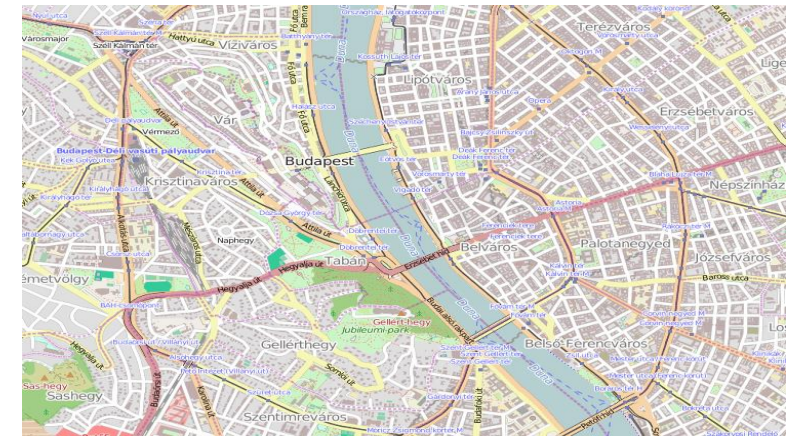
- Insourcing – Outsourcing – Crowdsourcing
- Crowdsourcing on the Internet
 - reaches many people
- Crowdsourcing advantages
 - Lower costs
 - Fast and extensive



Crowdsourcing forms

- Work, money making, pay services
 - **Amazon Mechanical Turk**
 - Human Intelligence Tasks – HITs
 - Best photo selection, recognize singer, rate service
 - Upwork (oDesk), Clickworker, ...
 - Passbrains, Testbird – software crowd-testing

- Free community crowdsourcing
 - SETI@Home
 - Wikipedia,
 - OpenStreetMap
 - Waze
 - ...



WIKIPEDIA
The Free Encyclopedia



OpenStreetMap
The Free Wiki World Map



Free community crowdsourcing

- Why free?

- Someone has to pay for the operation of the service (donations, membership, ...)
- Value added services, data provision can be free based on the community contributions
 - In other cases, it is payed also by the provider

- Community contribution

- Contribution FROM the community, FOR the community
- Not everyone participates
 - Active user <> one-time user <> freerider

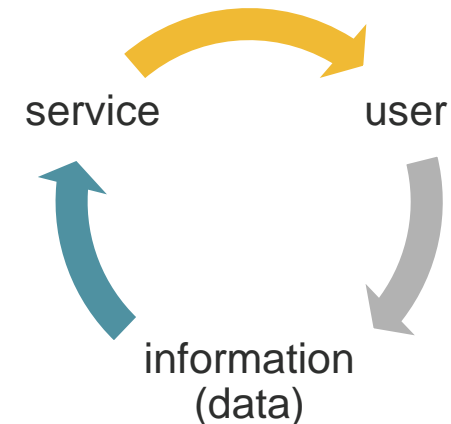


Crowdsourcing contribution

- Users' contribution
 - Wikipedia: 30 million registered users
 - OpenStreetMap: 1.8 million registered users (1% active)
 - Waze: 1500/25000 user simultaneously in Budapest/Párizs



- Many of the users only uses the service without adding anything to it
 - Freerider
- If there is no community contribution, there will be no service to use!



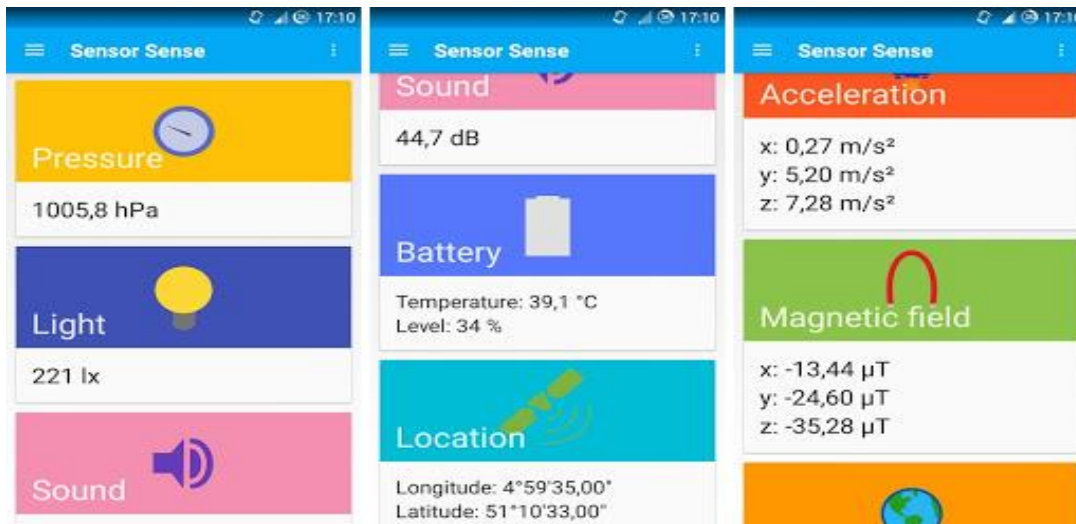
Crowdsensing, participatory sensing

- Community members involvement into active data gathering
 - Freeriders has to be changed to cooperative active users
 - Solution with mobile phones
 - Sensors + communication
- Crowdsourcing + crowdsensing
 - Everyone is contributing, there are no freeriders
 - Only a handful of users can bring in useful data



Smartphone sensors

- There are many sensors together with us in our smartphone
 - We bring all the sensors with us everywhere
 - We can monitor a large area, not just one single location
- Direct sensors (e.g., accelerometer, GPS)
- Derived sensors (movement detection)
- Information sharing



Smartphone – smartwatch sensors

- Air pressure – weather
- Light, proximity
- temperature – weather
- GPS – localization
- Accelerometer – movement, activity, location (gravity)
- Magnetometer – direction, location
- Gyroscope – Movement, activity
- Microphone – Voice, noise, event, (sleep: health)
- Camera – Photo, localization, (heartbeat: health)
- Heartbeat (Samsung Galaxy S5)
- Humidity (Samsung Galaxy S4)
- Step counter(Nexus 5)
- Harmful radiation (Sharp Pantone 5)
- UV radiation(Samsung Note 4)
- blood-oxygene (SpO2) sensor (Samsung Note 4)



Smartphone communication

- Smartphone – Internet (Cloud)
 - WiFi, mobile Internet
 - Real-time communication is essential in many times
 - Energy costs, communication costs
- Smartphone – other device (M2M)
 - WiFi Direct
 - Bluetooth, ANT+
 - NFC (Near Field Communication)
 - active-active and active-passive
 - IR communication, sound, picture (QR code)



Community sensing incentives

- Members of crowdsensing have to be motivated
 - Information from hardly accessible places
 - Long or difficult data input
 - Tasks that are not very popular
- Money as being a generic motivation (crowdsourcing)
- Proposed solutions
 - Gamification
 - Other incentives besides money

Crowdsensing and gamification

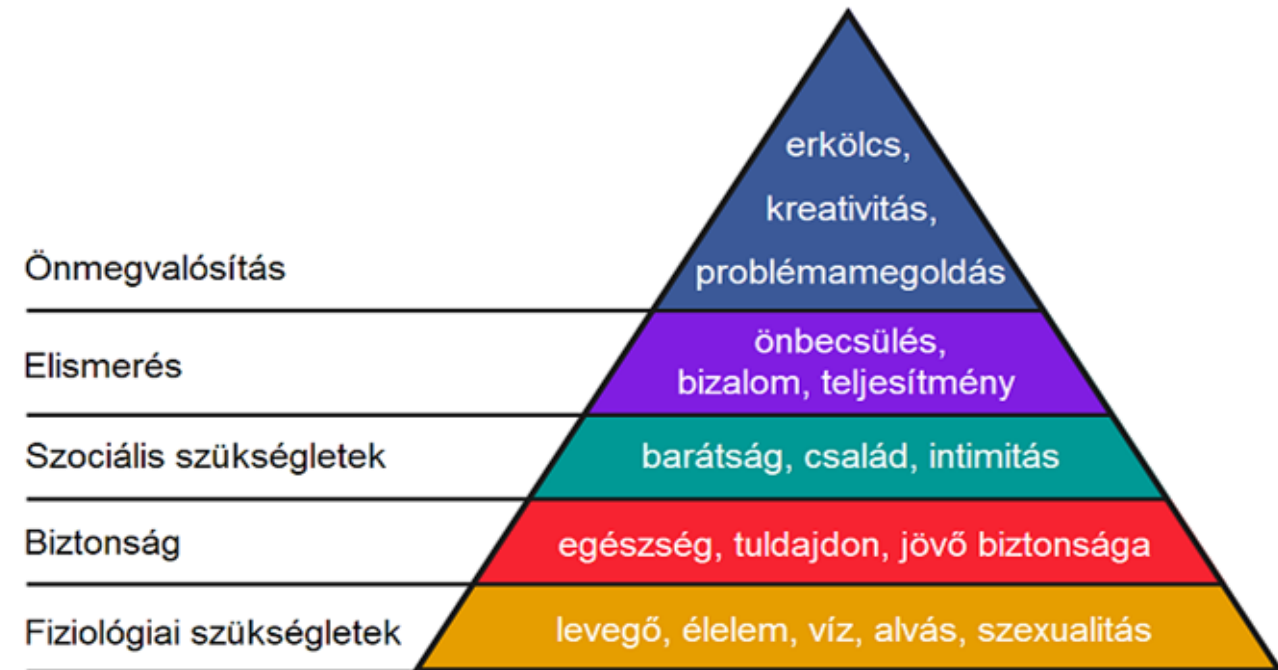
- Gamification can replace money
 - When playing a game, the users can do more difficult tasks with more enthusiasm
 - The reward is the game itself
- Gamification can help in popularize the service
 - New users can be involved
 - New areas can be incorporated
- Data input
- Data cleaning

Kort game



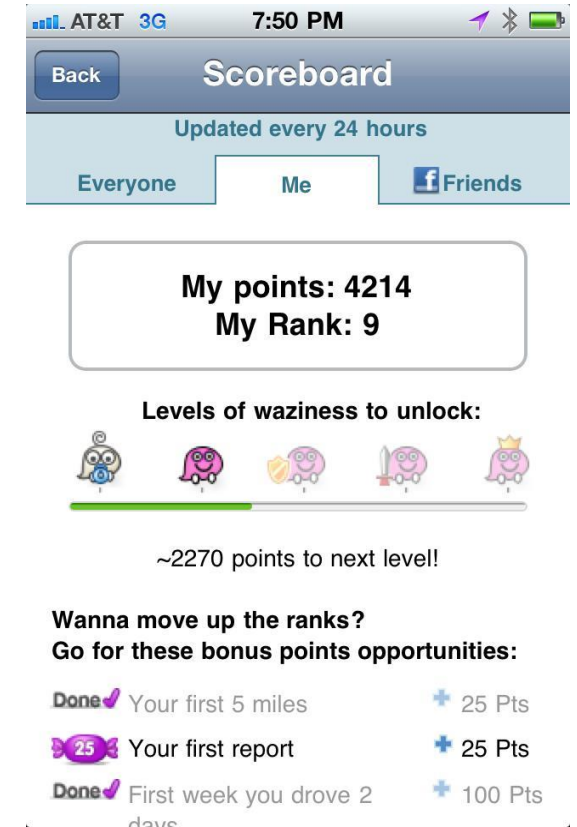
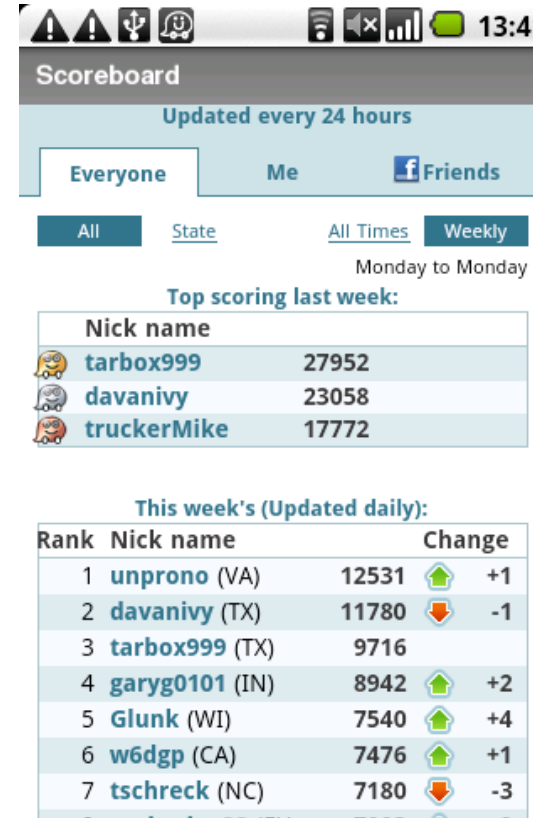
Gamification – basics

- Gaming mechanisms in non-playing environments
 - Theses: „Everybody likes to play” (Maslow reasoning)
 - Playful characters



Gamification in community services

- Incentives
 - Points
 - Badges
 - Levels
 - High score lists
 - Challenges



Smart City framework

- **Urban computing**

- High volume of heterogeneous data are collected, combined, and analyzed from different data sources deployed in urban spaces. The goal is to solve problems connected to city life.

- **Data sources:** sensors, vehicles, buildings, people

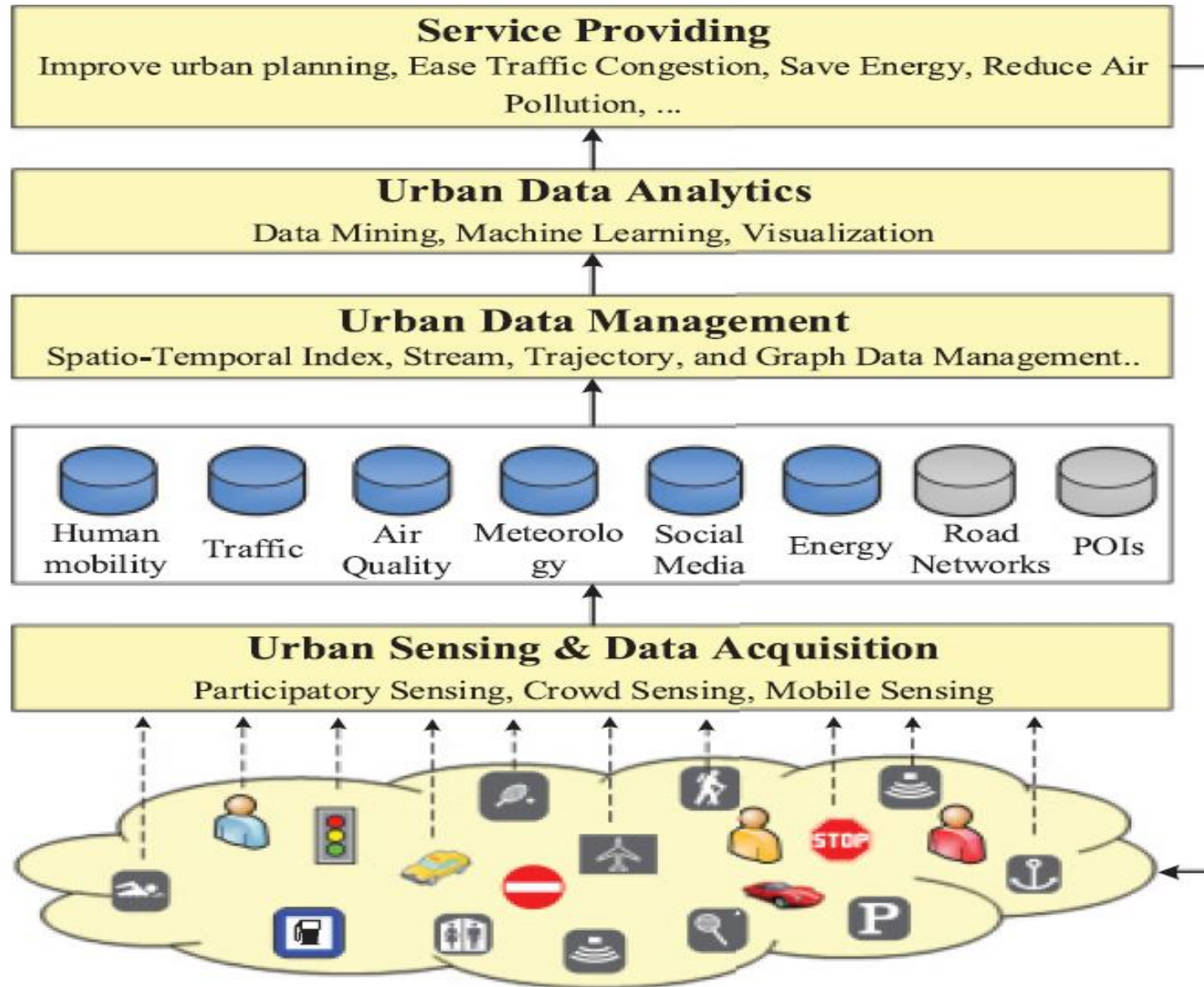
- Helps to improve sustainability and to understand future trends.

- **Framework elements**

- urban sensing
- urban data management
- data analytics
- service provisioning



Smart City framework



Challenges

- Urban sensing and data management:
 - non-intrusive, continuous data gathering on city-scale
 - energy-efficiency
 - privacy
 - sensors are unevenly distributed.
 - non-structured, implicit, noisy data.
- Analysis of heterogeneous data
 - efficient and effective adaptive learning techniques
 - visualization
- Hybrid systems: combining the physical and virtual worlds.



Crowdsensing applications

- Navigation and transport systems (mobility)
 - Waze
 - ParkRight / SENSIT /SpotOn
- Public transport
 - Futár
 - Moovit
- Governmental (participation)
 - Improve My City
- Turistic
 - CitySDK Turist API

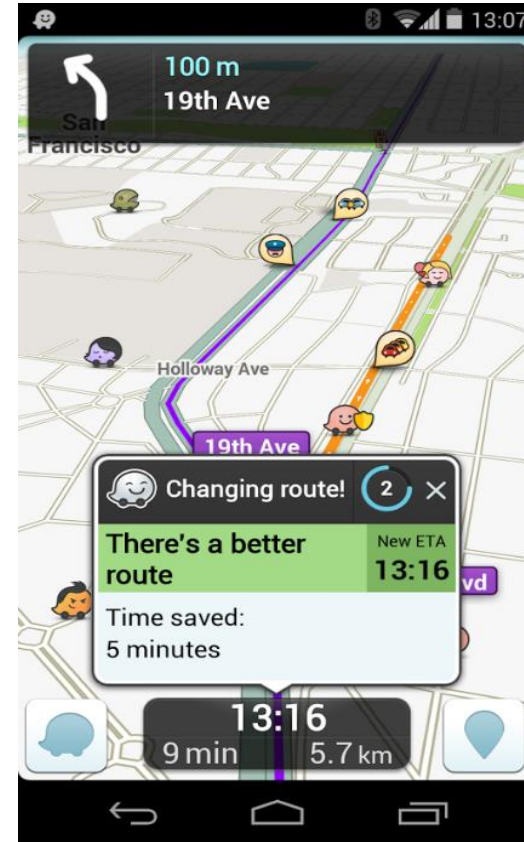
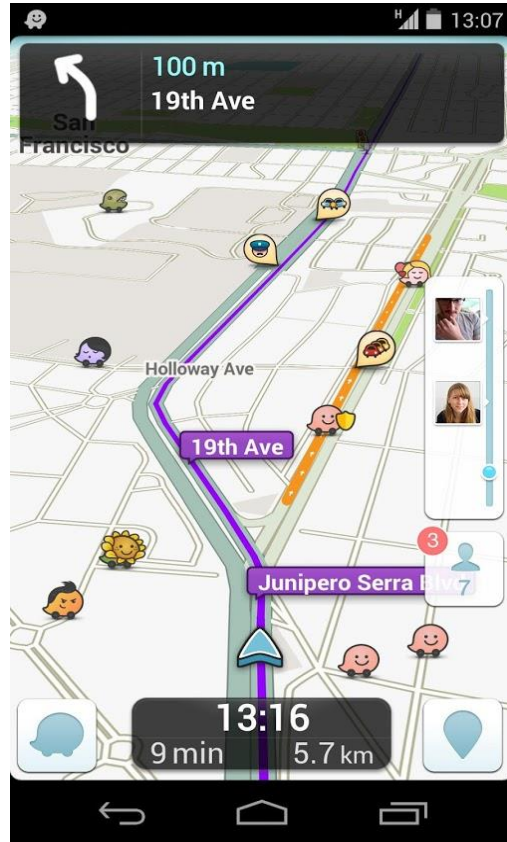
Crowdsensing apps – navigation and transport

- Waze
 - Crowdsensing
 - users trajectories are tracked by the system
 - map making, navigation, traffic forecast, congestion avoidance
 - real time route planning, traffic information, accidents, police control, constructions, etc. ...
 - live maps, based on users' routes, with volunteering editors
 - Petrol stations and prices
 - Gamification for incentives
 - More than 50 million users worldwide
 - Paying local ads



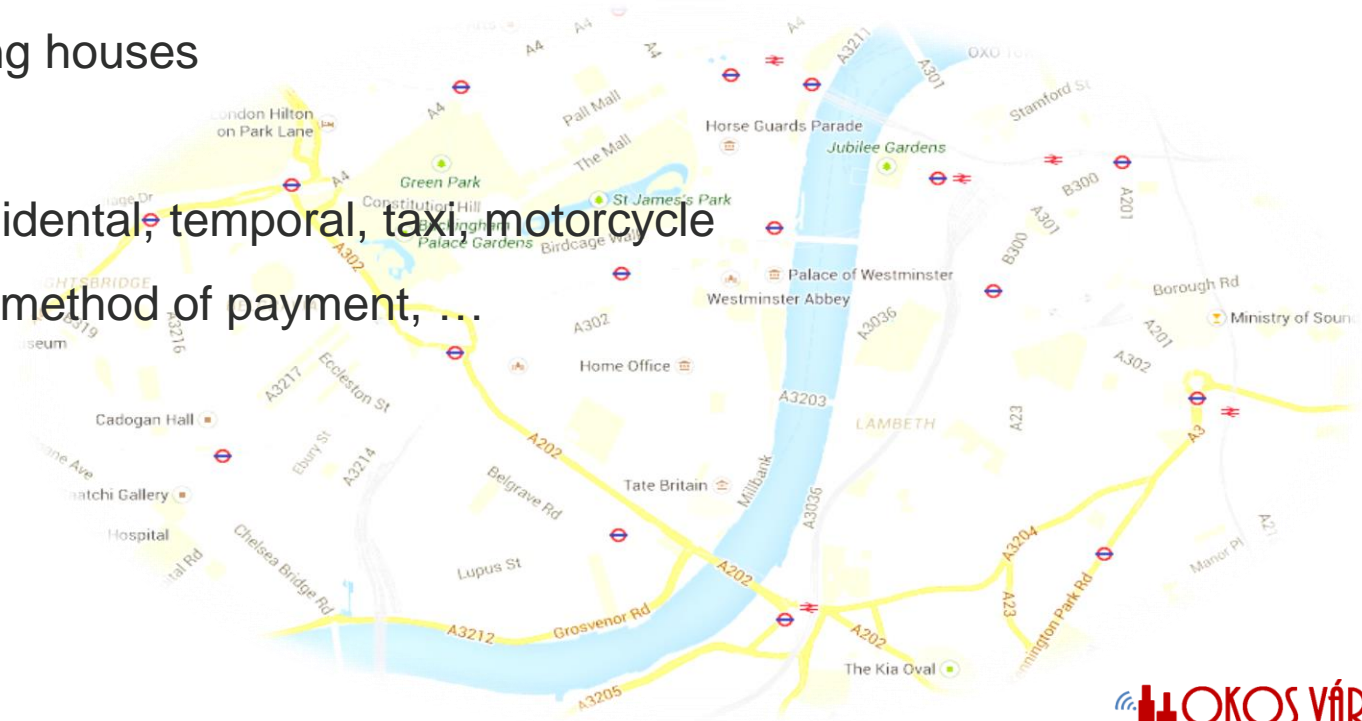
Crowdsensing apps – navigation and transport

- Waze



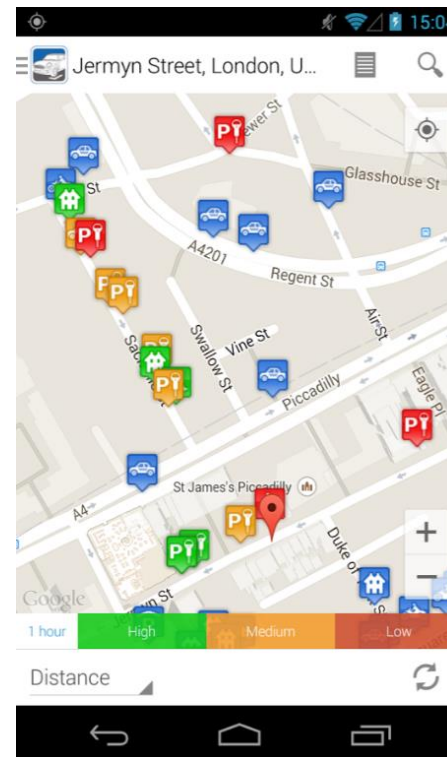
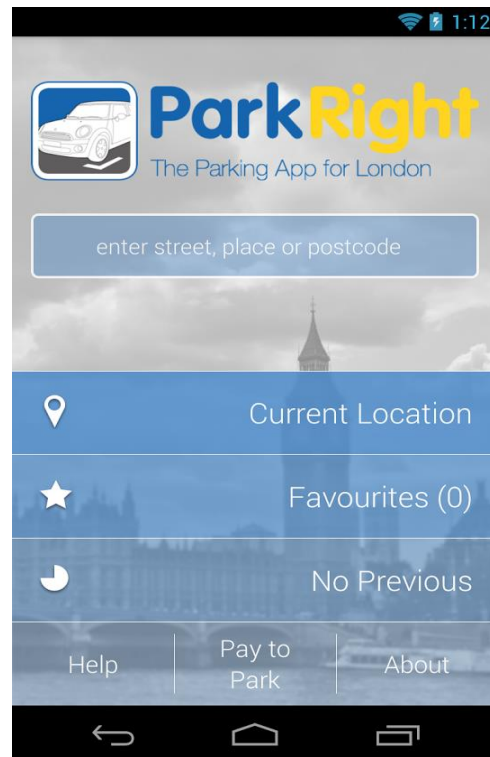
Crowdsensing apps – parking

- **Community vs. infrastructure solutions**
 - Sometimes community solutions are not easy...
- **ParkRight (non-community)**– London’s West End
 - 3000 parking places, real time occupation status
 - IR sensors
 - 41,000 parking places on streets and parking houses
 - Parking place location
 - Parking place types: pay, handicapped, residential, temporal, taxi, motorcycle
 - Parking information: prices, opening hours, method of payment, ...



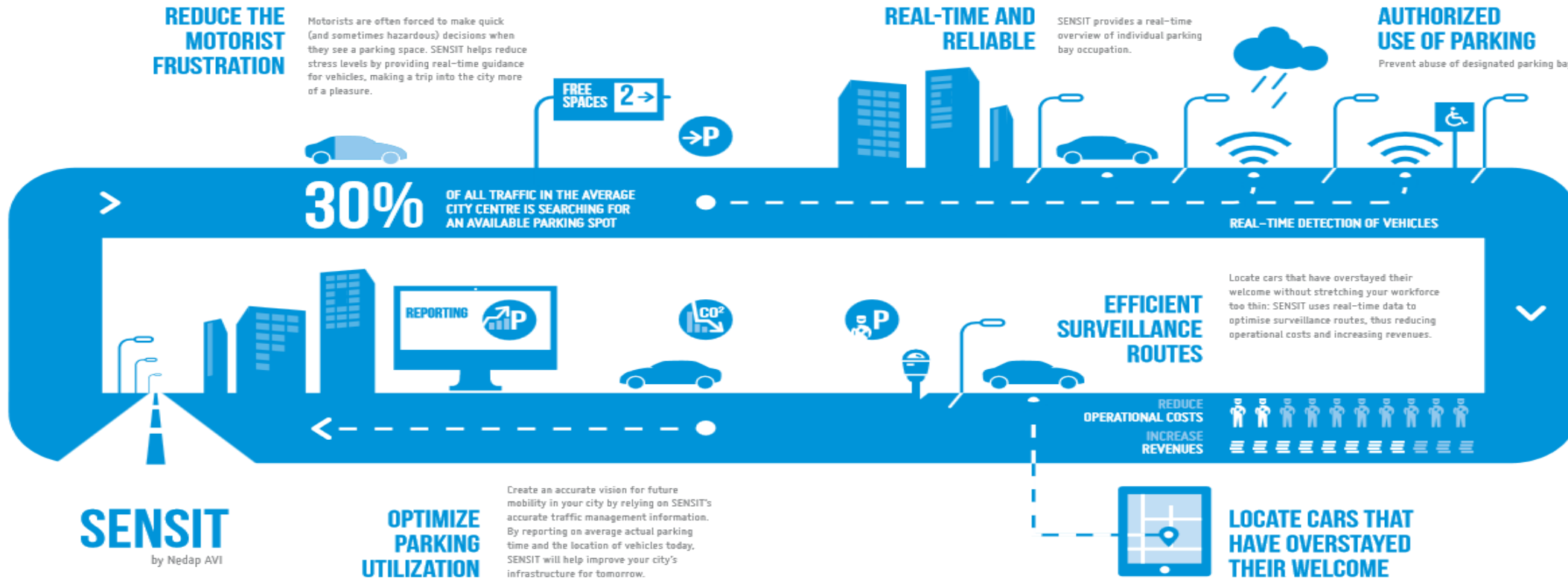
Crowdsensing apps – parking

- ParkRight - SmartEye sensors (Smartparking)
 - IR sensor on batteries
 - Wireless communication with the solar powered zone controllers
 - Integrated mobile app



Crowdsensing apps – parking

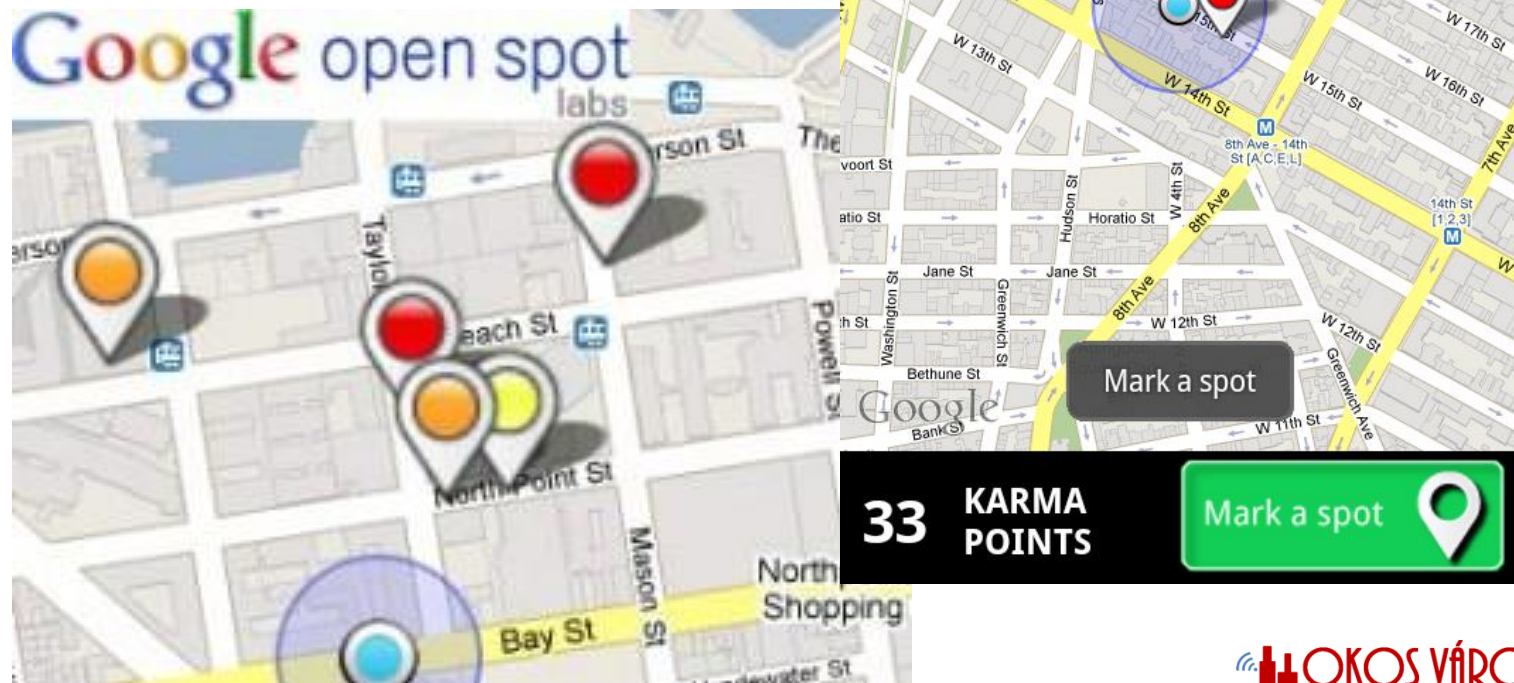
- SENSIT (non-community)
 - Singapore, New York, Moscow
 - Analysis, control, warnings



Crowdsensing apps – parking

Google Open Spot (2010)

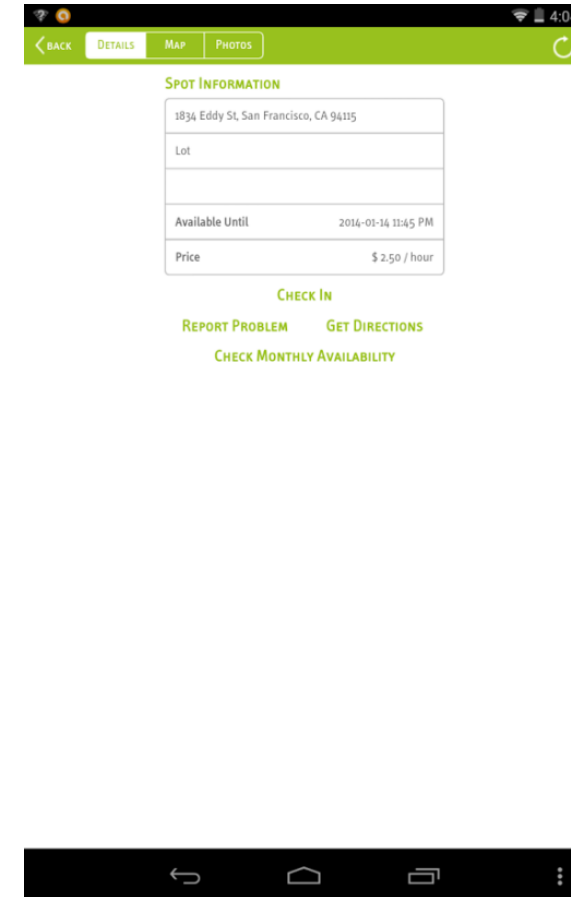
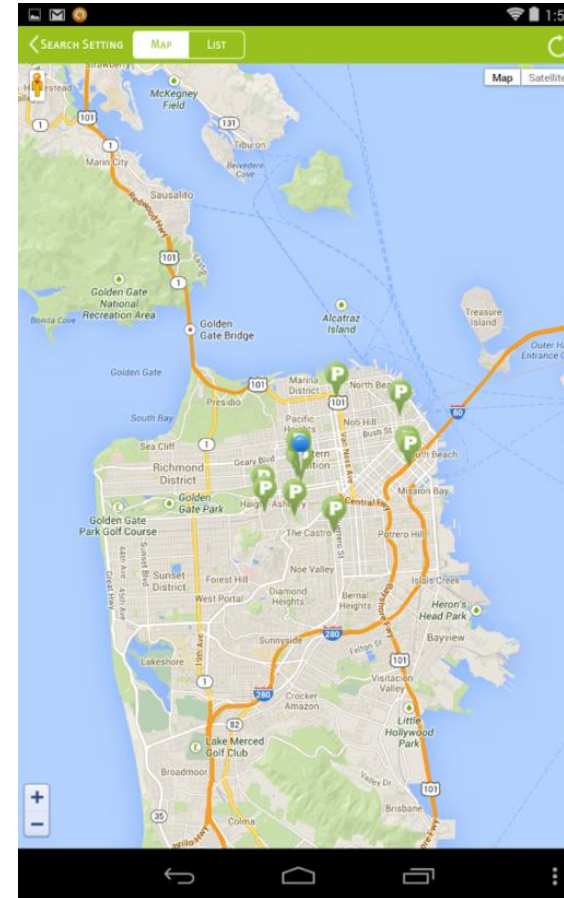
- Community-based – when someone is passing by an empty slot, he/she marks it on the map
 - Colour code shows how current is the informations
 - After 20 minutes the mark disappears from the map
- Seems to be a good idea, but nobody is using it...



Crowdsensing apps – parking

SpotOn

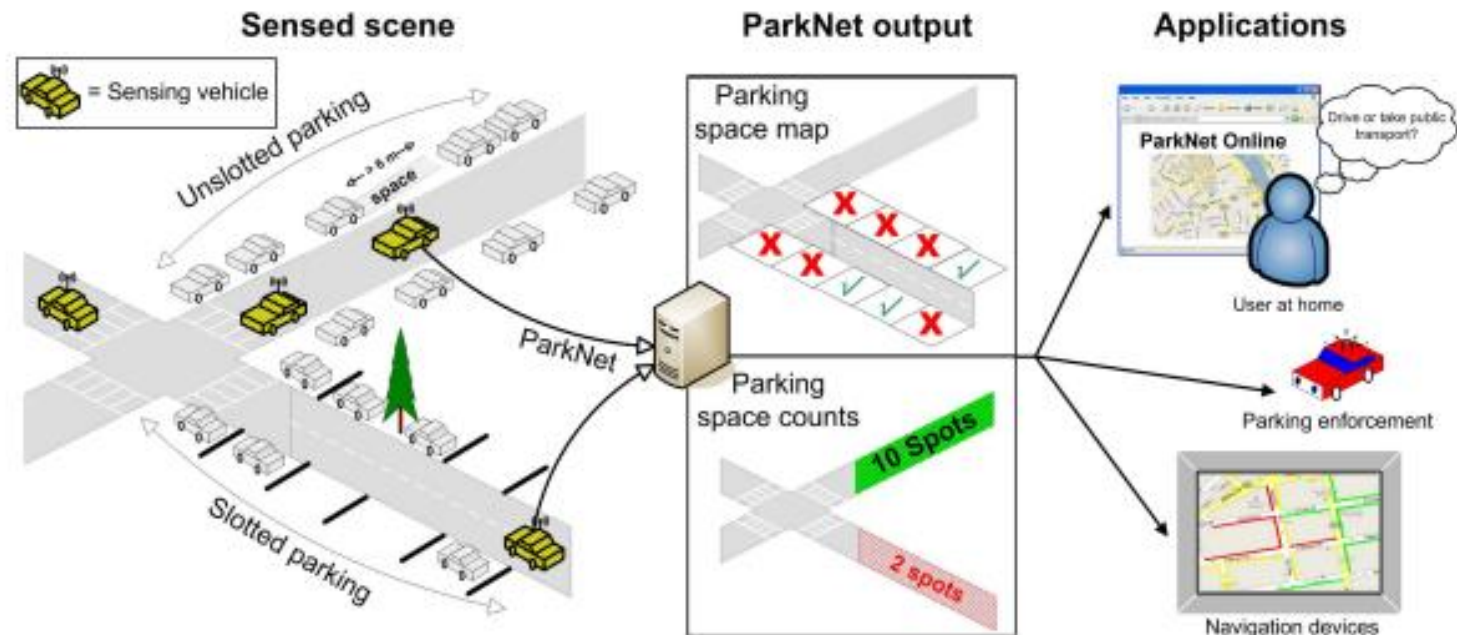
- Free registration
- **Selling private parking places**
 - Parking place in front of your house or garage door
 - When not at home, the slot is used and is paid for
 - Logging in and out when parking/leaving
 - Problem: someone was using the place and forgot to check out.



Crowdsensing apps – parking

ParkNet

- The **cars collect information autonomously** when passing by free parking slots.
 - Ultrasonic proximity sensors on „right side” of the car
 - Challenges: GPS accuracy, parallel lanes, etc.
 - Webcams for double checking
 - Slotted vs. unslotted



- Experiments show that by using GPS data from 500 taxis a reliable data set can be collected within a city, and it's 10-15 times cheaper than with deployed fixed sensors

Crowdsensing apps – public transport

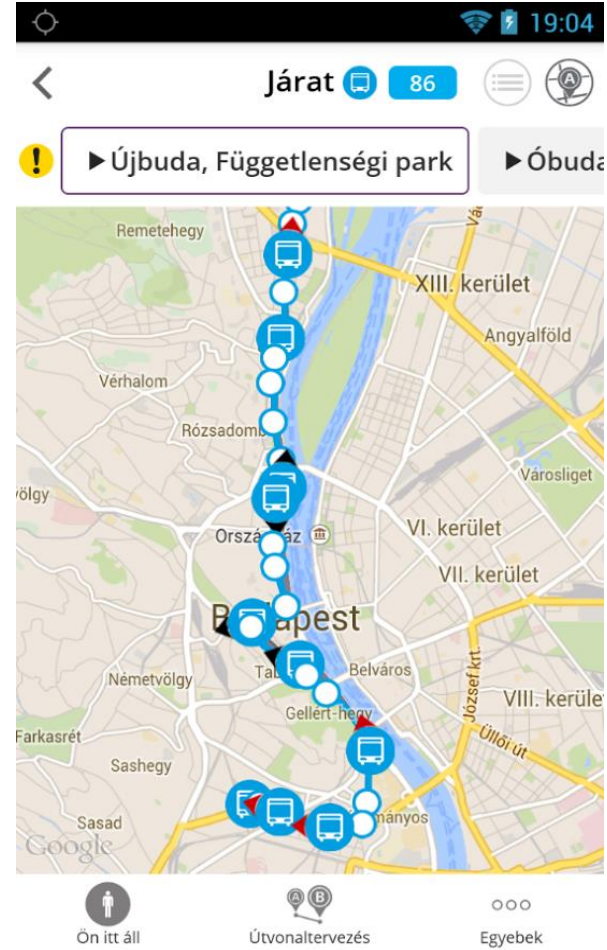
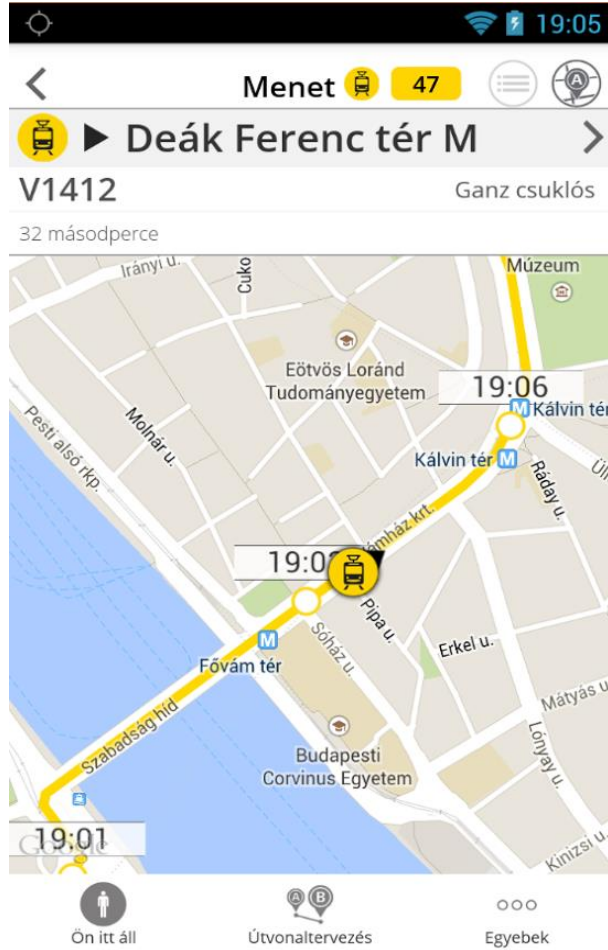


- Futár
 - BKK closed system
 - GPS on vehicles, central database, displays connected to the central unit, mobile app
 - on 2350 vehicles (bus, tram, trolley)
 - Real-time information
 - Route planning
 - **Not** crowdsourcing, costs: 6.7 Billion HUF



Crowdsensing apps – public transport

- Futár



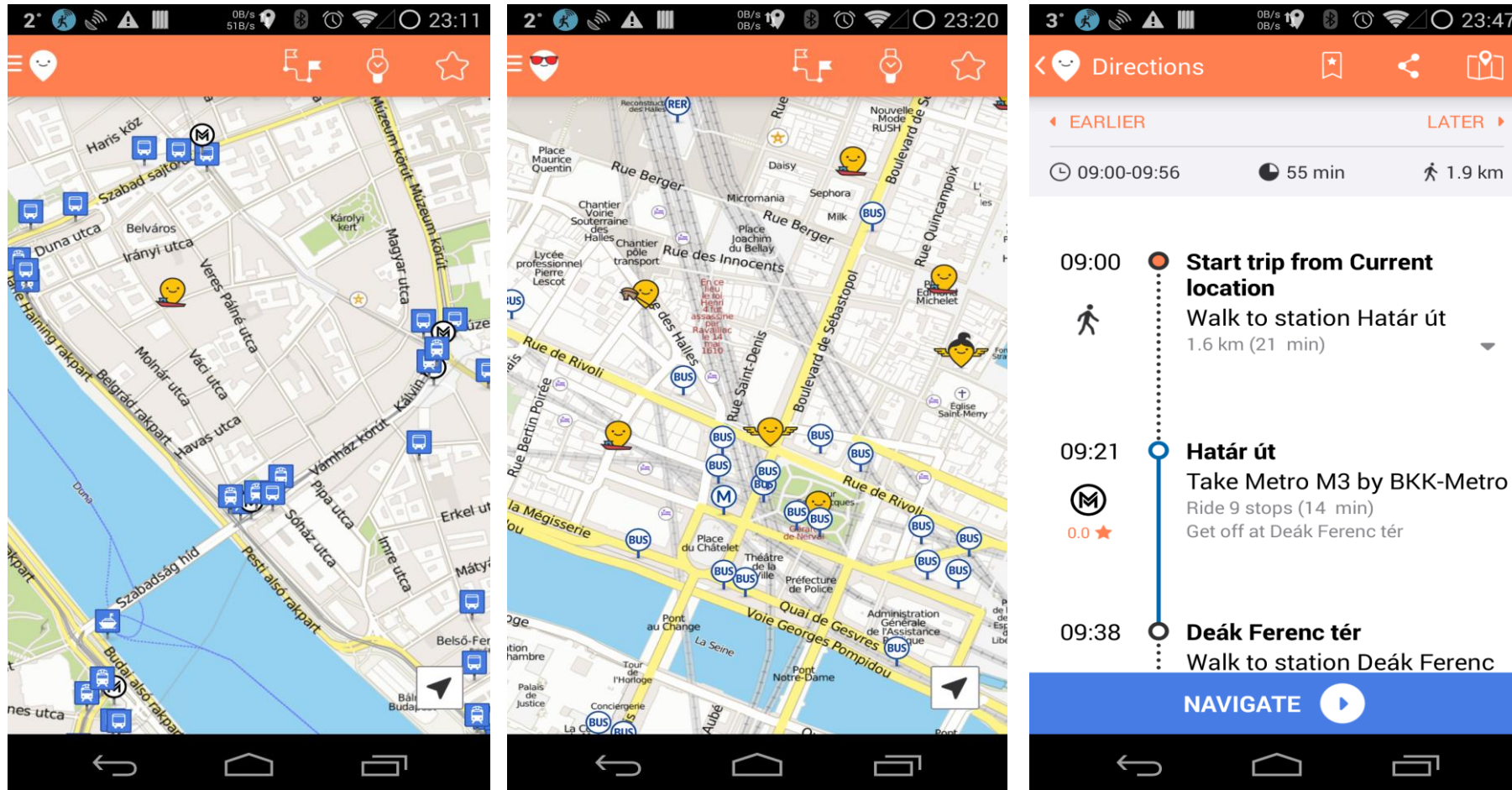
Crowdsensing apps – public transport



- Moovit
 - Similar to waze but for public transport
 - Passive data gathering – speed, GPS position
 - Active reports – cause for delays, crowded, style of bus driver, etc.
 - 500 cities, 6.5 million users
 - Bus, tram, metro, trolley, boat, train
 - Budapest (BKK) and Székesfehérvár are also integrated, but very few users
 - Timetable information from GTFS database (General Transit Feed Specification)
 - Real-time timetables
 - Route planning, suggestions, sharing with friends
 - Incentives by gamification

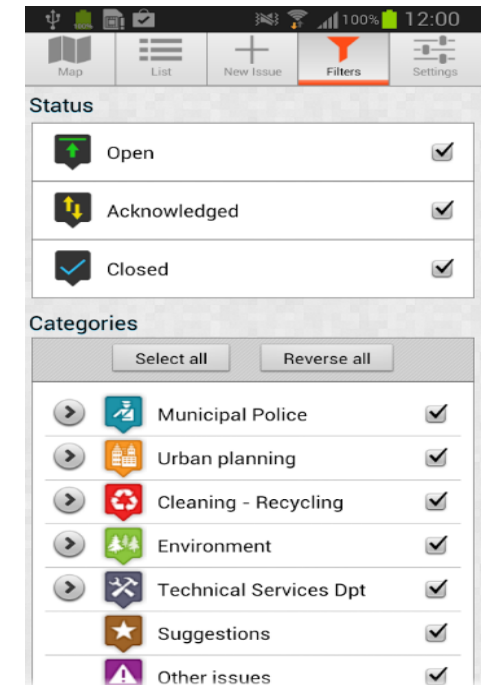
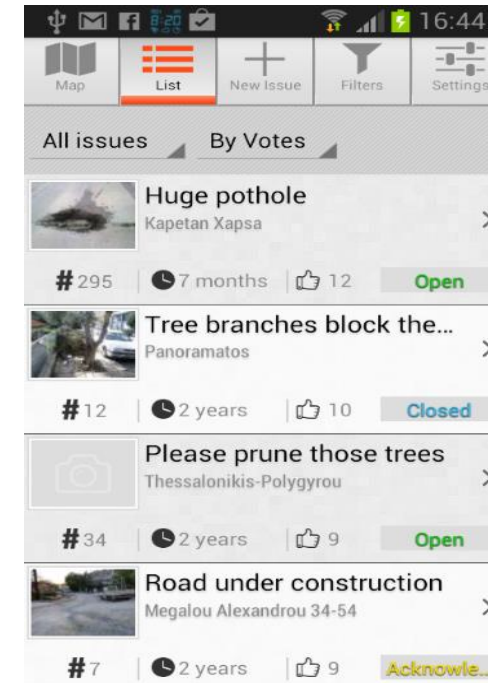
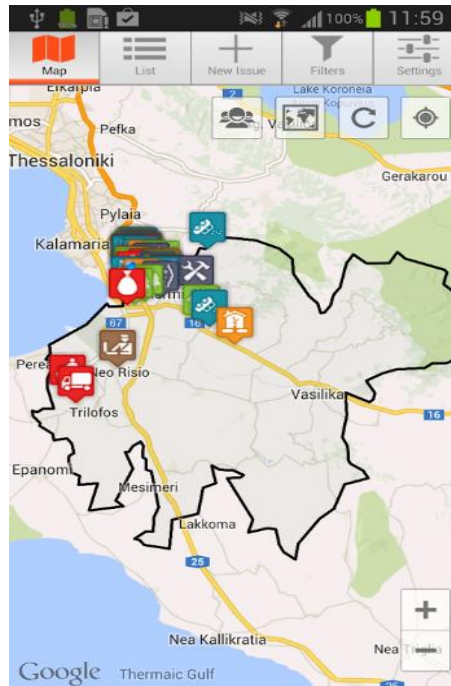
Crowdsensing apps – public transport

- Moovit



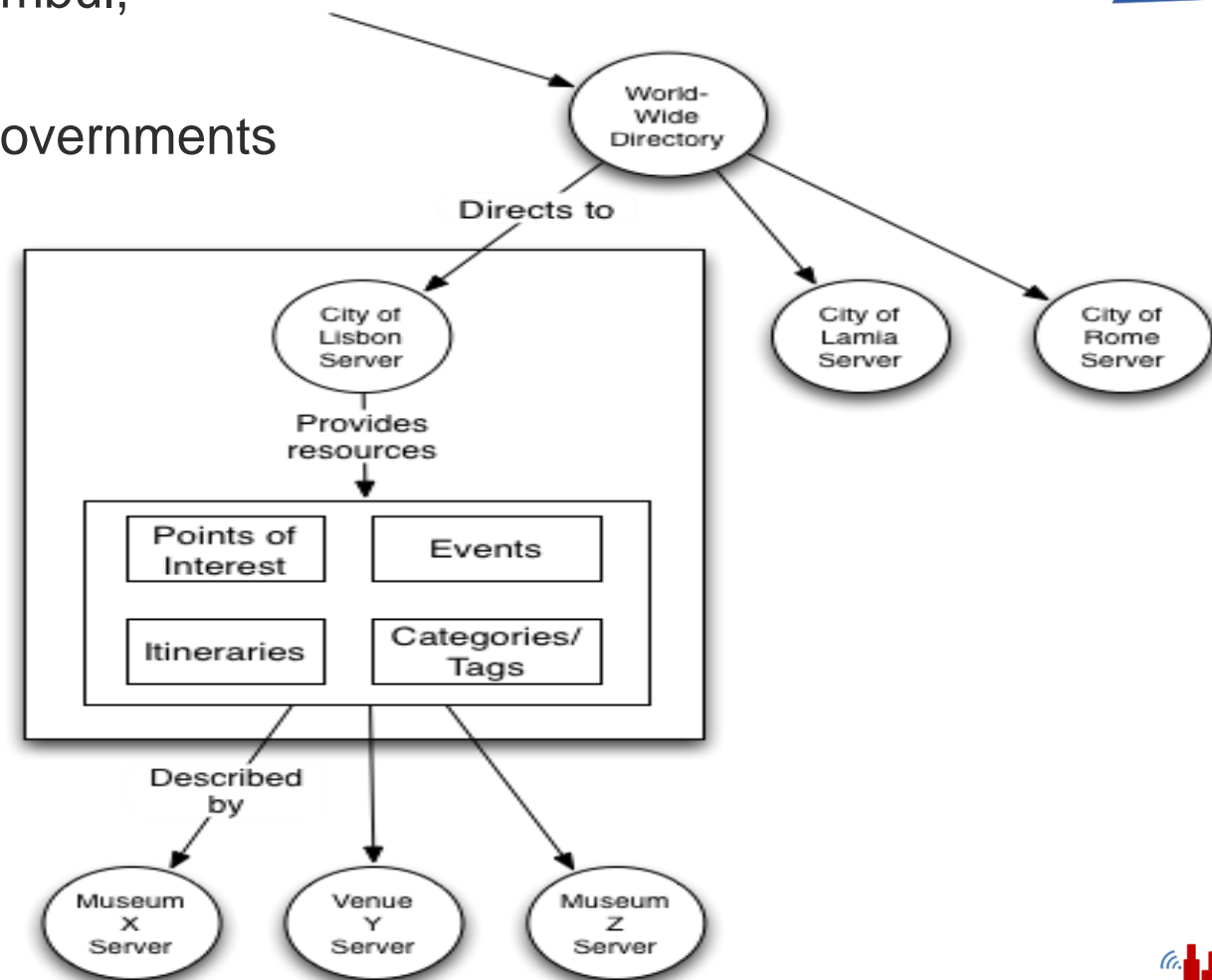
Crowdsensing apps – government

- Improve My City
 - Local, city level problem management
 - Based on the collaboration of the city and citizens
 - Citizens as real-time, cost-effective „sensors”
 - Suggests solutions, sets priorities
 - **Citizens’ opinion matters!**



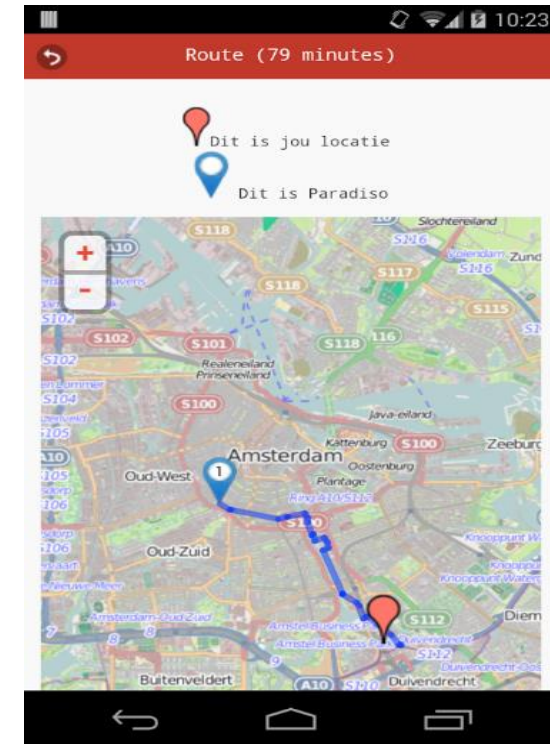
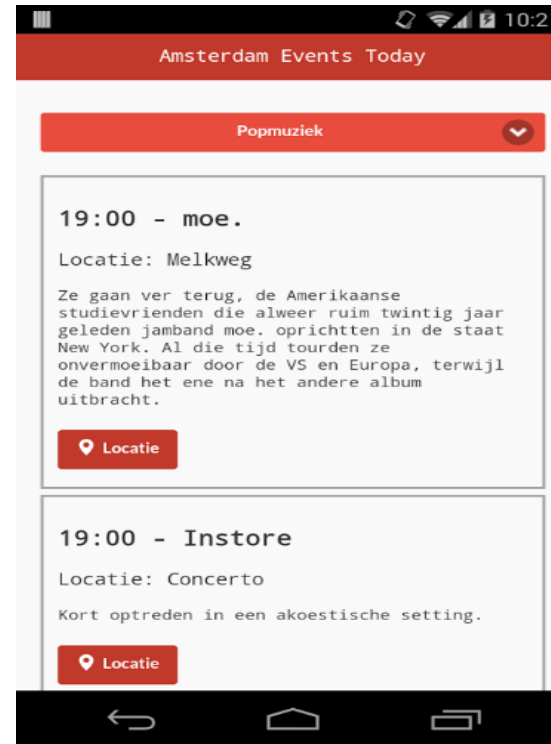
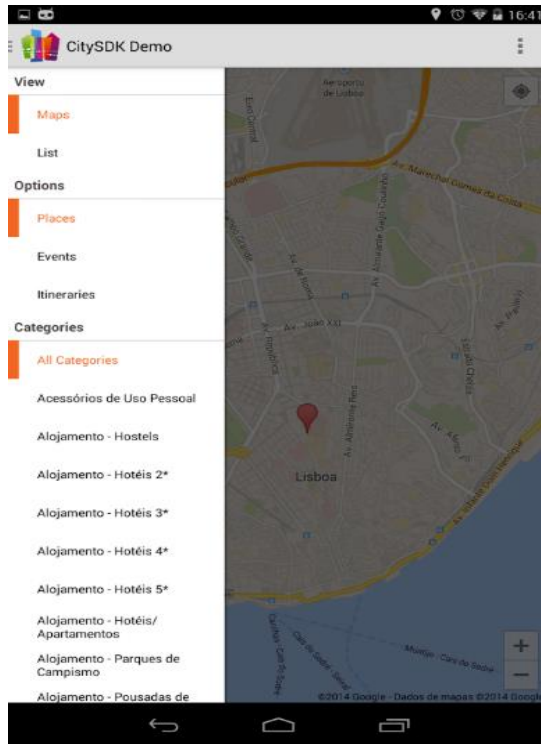
Crowdsensing apps – touristic

- CitySDK (EU funded projects)
 - Amsterdam, Barcelona, Helsinki, Istanbul, Lamia, Lissbon, Manchester, Rome
 - Open Data access provided by self-governments
 - Open Data + Cities + Developers + CitySDK Toolkit
 - CitySDK Tourism API



Crowdsensing apps – touristic

- CitySDK – Virtual Tour



Közösségi alkalmazások – összegzés

- Crowdsourcing + crowdsensing + Open Data
- Okos városokban
 - Közlekedés, tömegközlekedés, *kerékpárköcsönzés*
 - Parkolás, dugó problémák, tömegközlekedés optimalizálása
 - Önkormányzati jelzések, visszajelzések
 - Turisztika, események