香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

Wherami

Indoor Positioning and User Analytics for a Smart City

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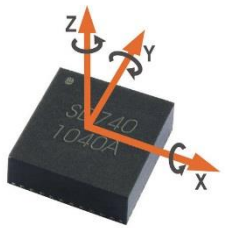
A Scenario: Personalized Location-based Ads

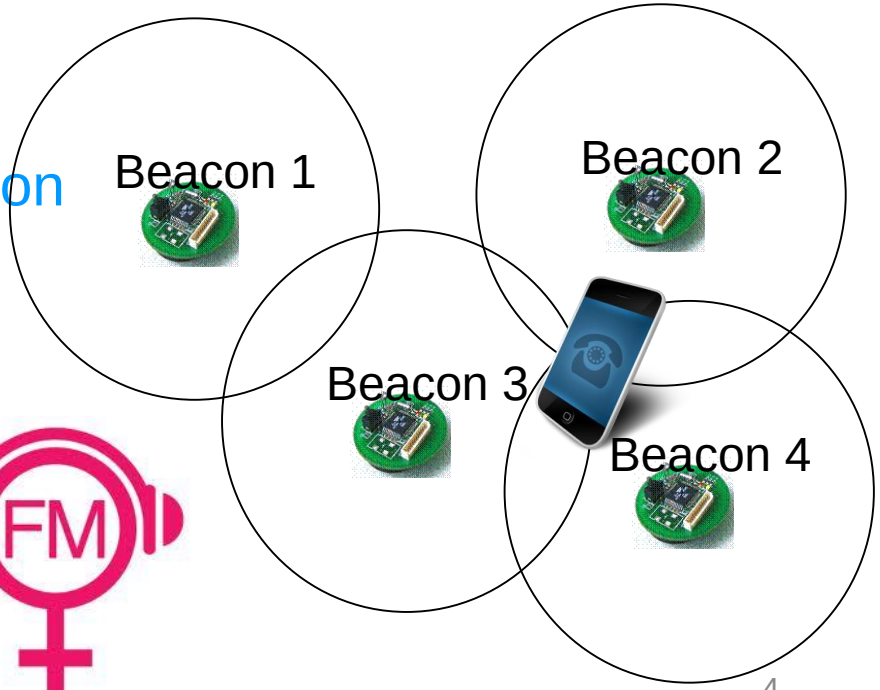
Wherami: Client-based Indoor Localization Technology

- Real-time positioning
- Real-time navigation
  - Destination search
  - Best path selection
  - Moving trajectory
  - Panoramic visual clue
- Targeted services
  - Nearby facility search
  - Program search
  - Event/Ad prompt

Fingerprinting Integrating with Other Signals

- Wi-Fi
- Bluetooth (BLE)/iBeacon
- Dead reckoning/INS (inertial navigation system)
  - Step counter, gyroscope, accelerometer, etc.
- Magnetic field
- GPS/AGPS/NLP (Network location provider)
- Barometer
- Ultrasound
- RFID
- Etc.



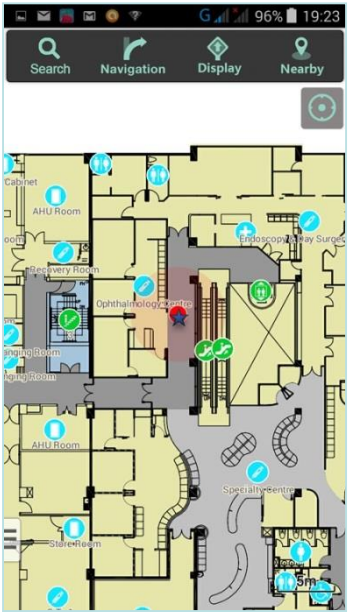


Cutting-edge Technologies

- **Accurate and efficient**
  - Precision 2m ~ 5m
  - Instant Update with estimation time < 1s
  - Seamless indoor-outdoor roaming
- **Low cost, easy to deploy and use**
  - Based on WiFi fingerprinting
  - Non-intrusive and transparent to existing WiFi infrastructure
- **Seamless integration with other applications with dedicated API**

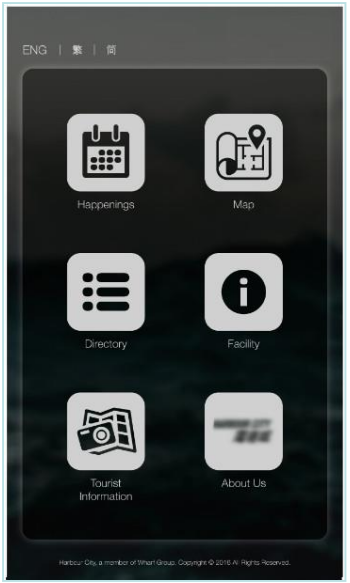
Deployment At Union Hospital

- Where is the Pathology Centre?
- I am coming for a body check, have just taken X-ray, what should I do next?
- Where is the nearest toilet?



Deployment at shopping mall

- Where is shop XYZ?
- How to get to there?
- How to get there on wheelchair?
- What promotions are there?



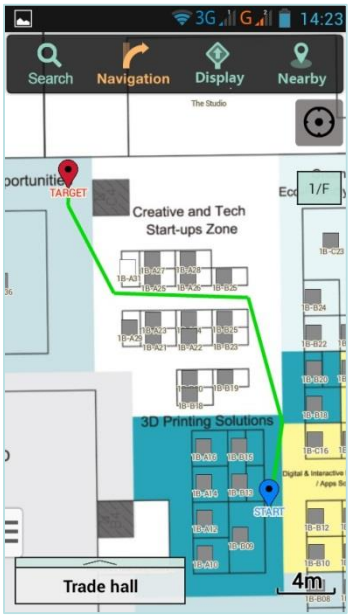
Shopping Mart or Superstore

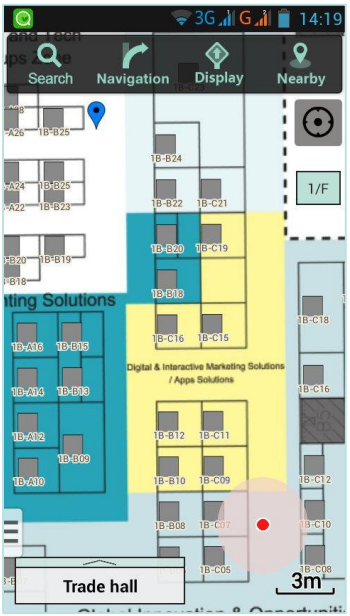
- Aim for better shopping experience in large area with many aisles
  - Location-based promotions
  - For bargain hunters
  - For shoppers with a shopping list
- Targeted advertisement (behavior analysis)

Context-aware Computing or Smart Space: Museum and Theme Parks

Hong Kong Convention and Exhibition Centre

- Where is the xyz company booth?
- Are there any forum discussions this afternoon and where are they held?
- Where is the “3D Printing Solutions” zone?
- Where is my friend?

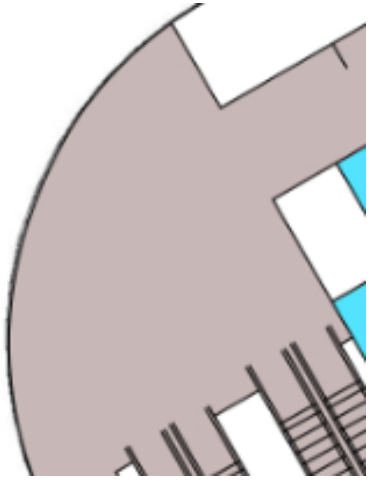


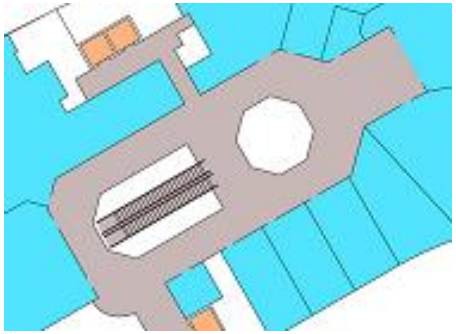


Sensor-Based IoT Solution for Wi-Fi Tracking

Experiments in a Shopping Center

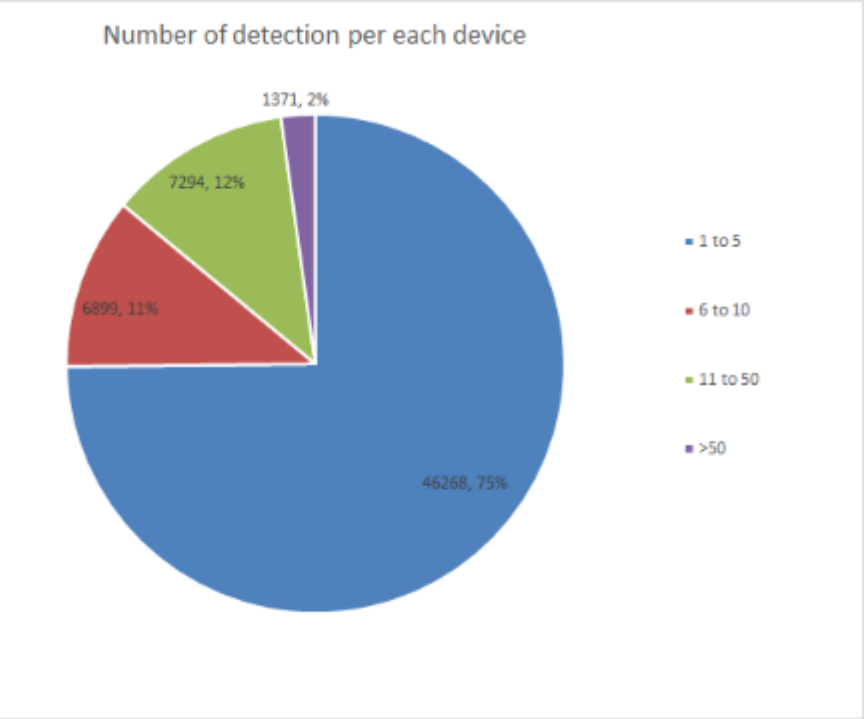
- G/F, 1/F, 2/F and 3/F in a Shopping Center





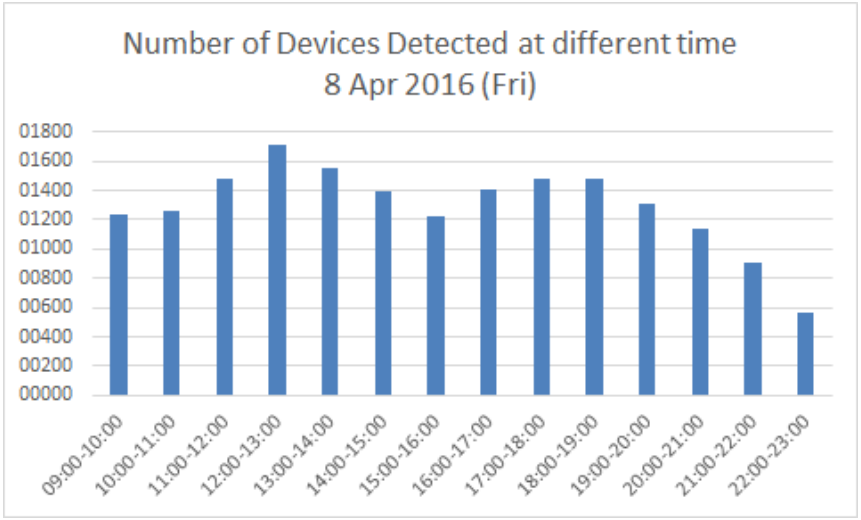
Dwell Time: Number of records collected per detected device

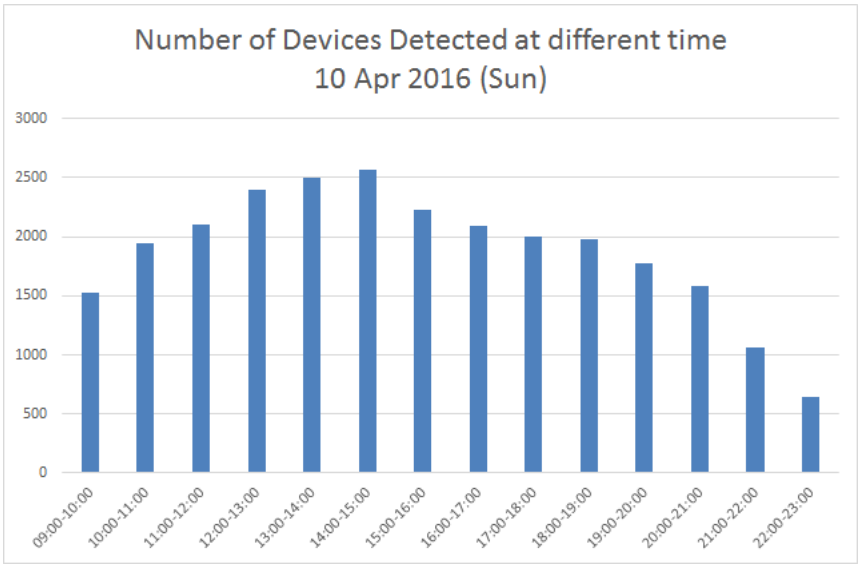
- Number of records detected for each individual devices indicate the station time of the customer
- Most of devices are detected 1-10 times (86%)
  - Peoples walk through the area without stop
  - Go to the MTR through the mall
  - Go into the wet market in 1/F
- 11% of devices are detected 11-50 times
  - Peoples walk around the shops
  - Students play around the toy shops in 2/F
  - The parents/domestic helpers wait to pick up the kids after tutorial class/interest group in 3/F
- Only 2% of devices are detected more than 50 times
  - Elderly persons sit and walk around
  - Shop keepers, security guards



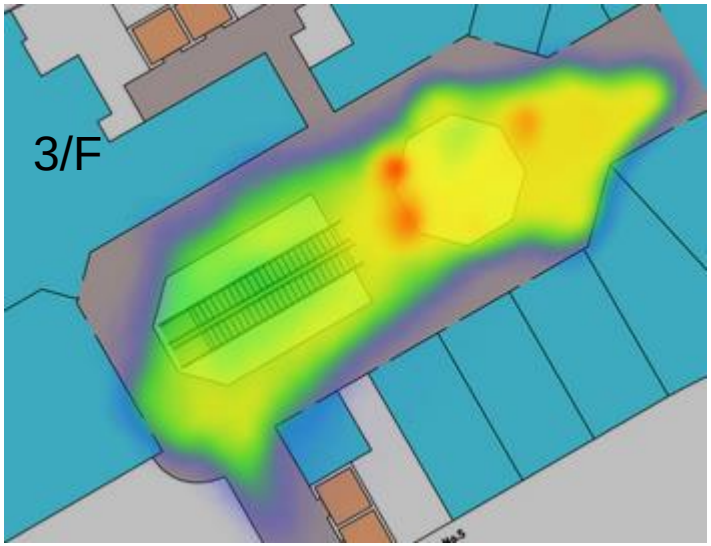
Number of devices detected at different time

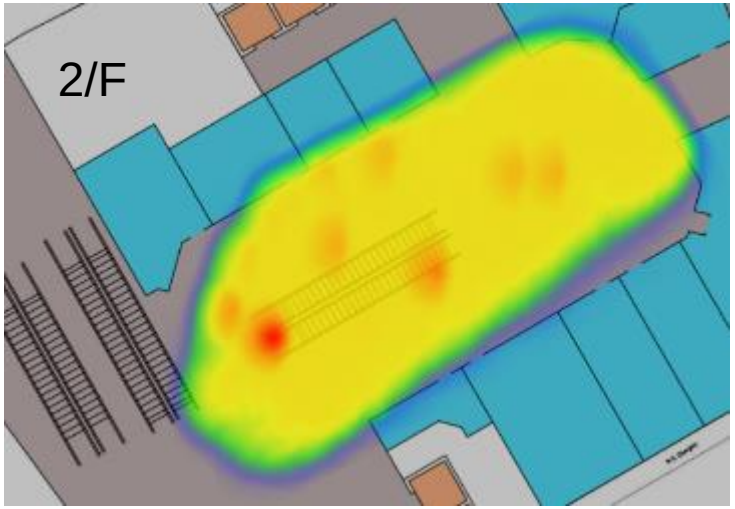
- A camel shape of the bar chart on Fri indicates there is small increase in people during lunch and dinner time
- More peoples are detected on Sun than Fri
- There is a peak of people in the shopping mall in Sunday afternoon

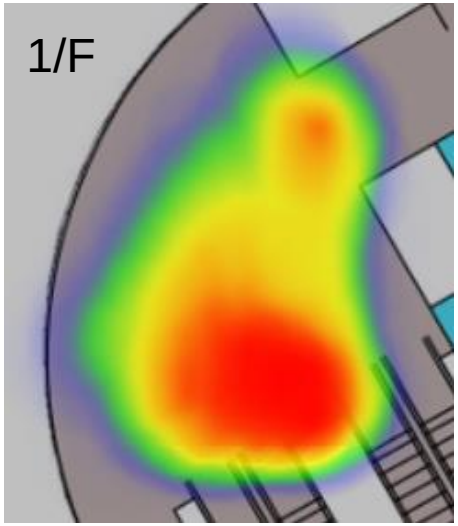


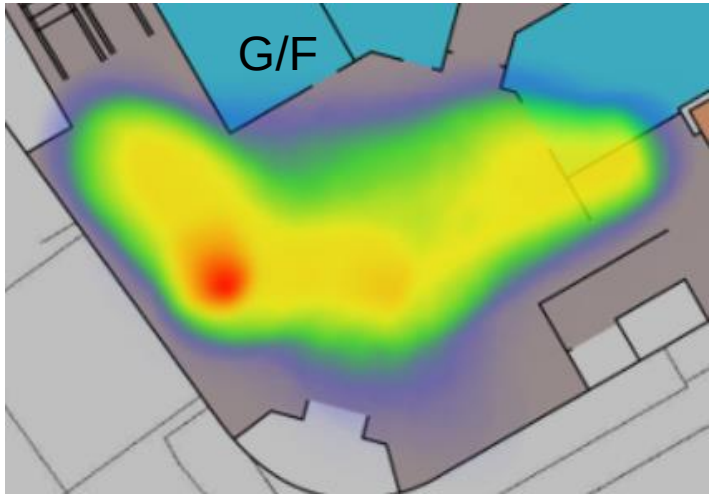


Heatmap of 8 Apr 2016 (09:00-22:00)

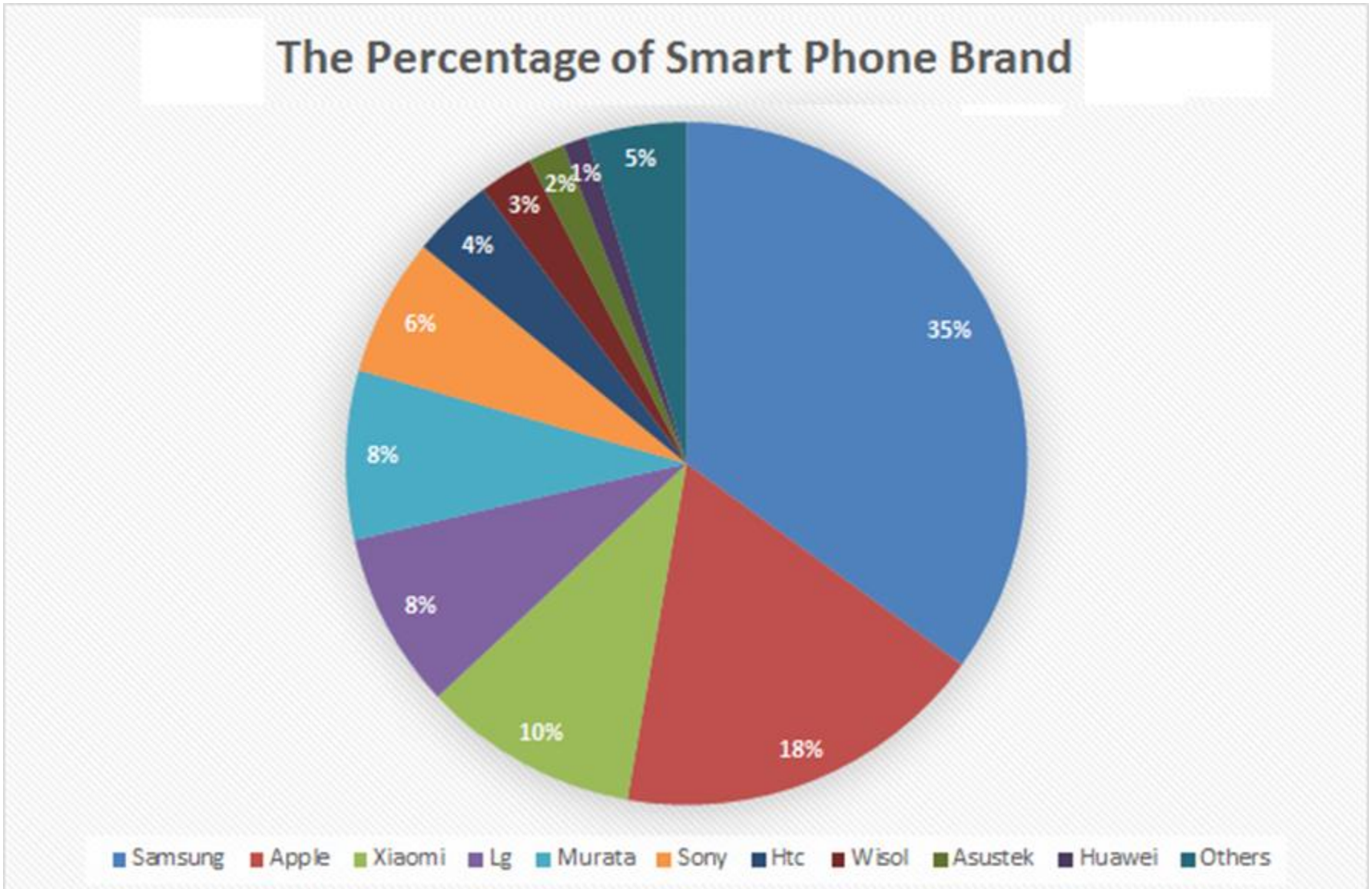




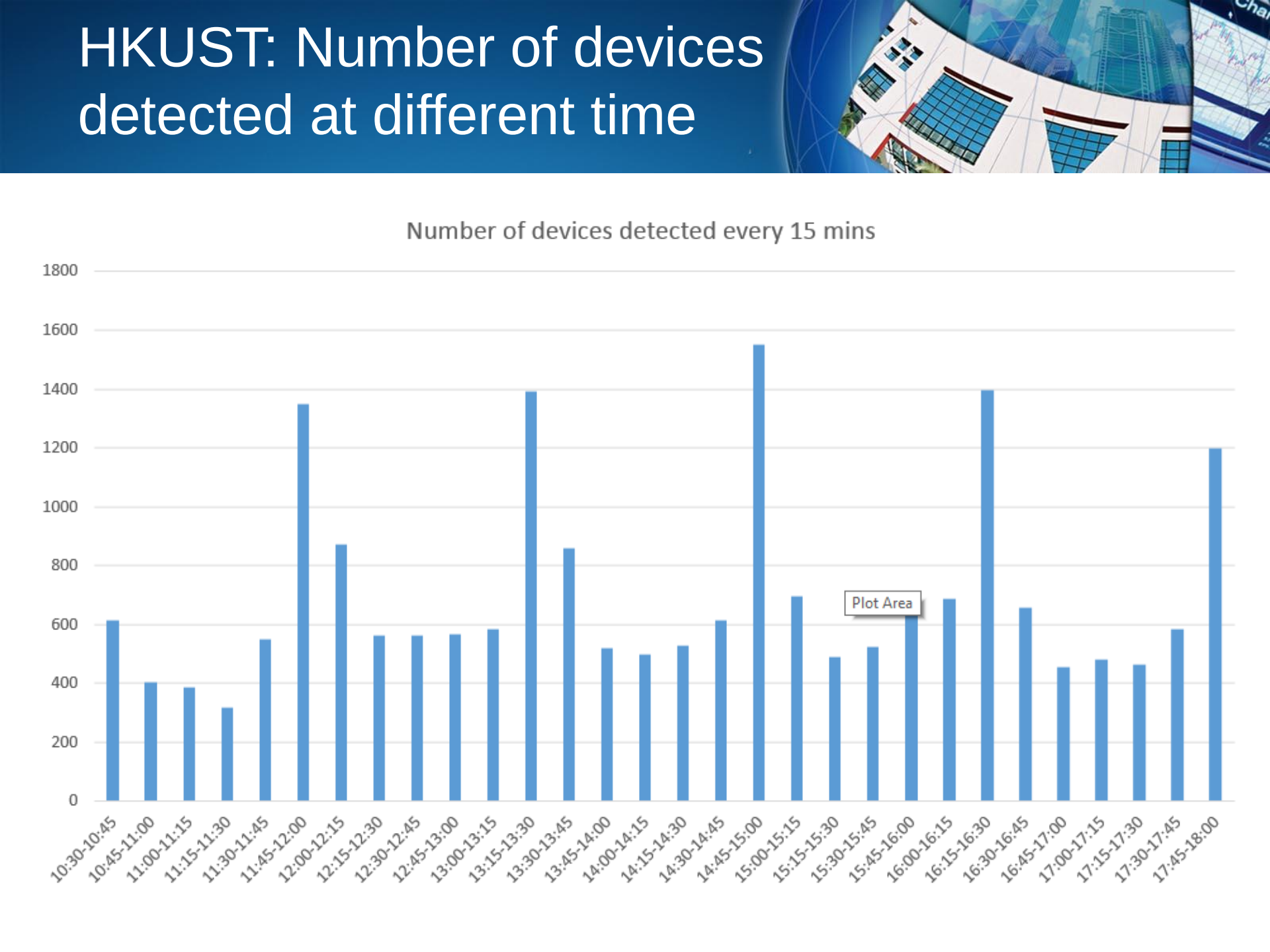




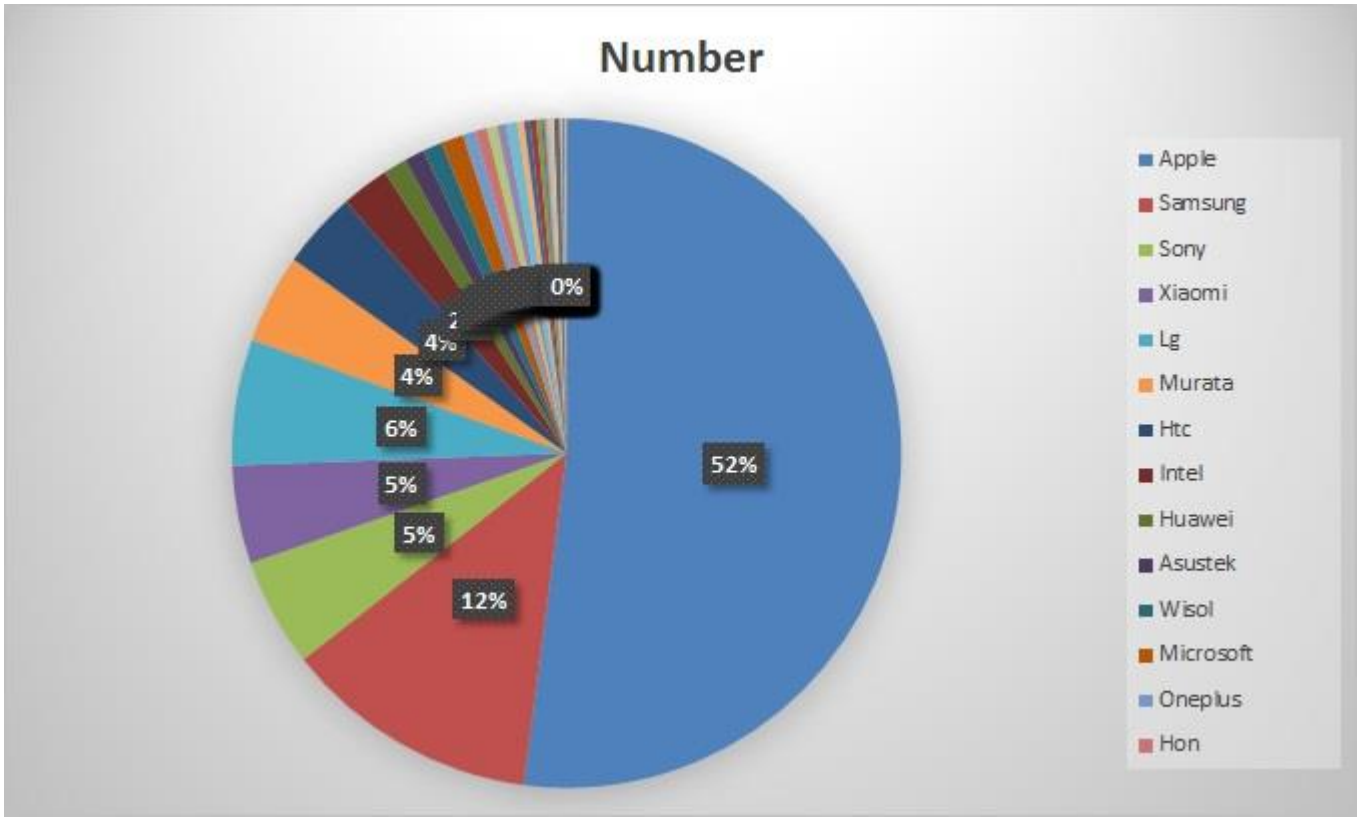
Vendors of the devices



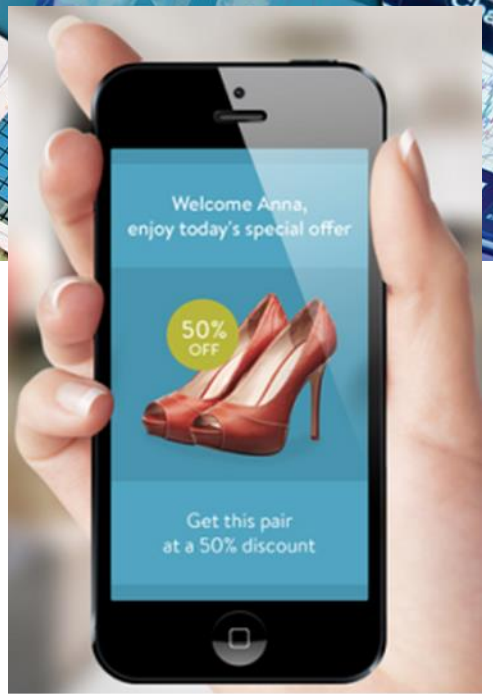
HKUST: Number of devices detected at different time



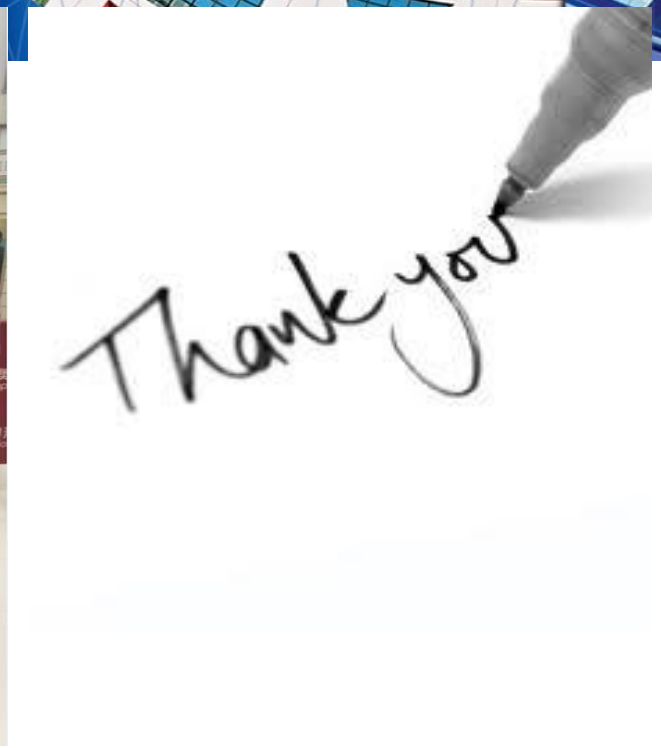
Vender of the devices



Location, Location, Location!



- A multi-billions market
- Save energy
- Traffic or crowd control
- Malls, super-marts or exhibition centers
  - Help customers to find items, shops or booths
  - Location-based recommendations, mobile advertisement and marketing
  - Enable O2O (online-to-offline) business
  - Track people and crowd/flow analysis
  - Customer behavior
- Airports
  - Help tourists to find their gates for flights
  - Shop while waiting for flights
- Health care and hospitals
  - Track people, patients, staff, etc.
- Social applications: finding nearby people sharing the same interest
- Location-based games (e.g., treasure hunt)
- Track assets



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