Application Lecture 4: Pervasive and Social Sensing

7COM1030 – Multicast and Multimedia Networking

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Topics

- Pervasive Sensing
- Social Sensing
- Internet of Things

Pervasive Sensing

- The need for understanding, serving, and controlling the physical world demands the emergence of ***sensing everywhere***. Collaborative and pervasive sensing is the future.
- People's ownership of smartphones can make pervasive sensing a reality.

Picture from *Wireless Multimedia Sensor Networks: Challenges and Opportunities*, Sajal K. Das, University of Texas, 2011

Key Roles of Smartphones

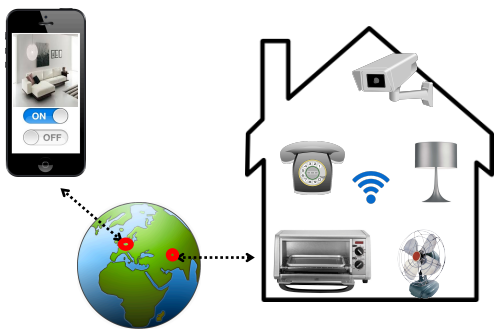
- Smartphones as **sensing nodes**:
  - A typical iPhone 5 has eight built-in sensors: accelerometer, GPS, ambient light, dual microphones, proximity sensor, dual cameras, compass, and gyroscope.
- Since smart phones are rich in processing and storage resources, they can act as **management nodes** in a wide range of sensor network deployments.
- Well-established wireless/mobile technologies act as reliable and hassle-free underlying communication protocols.
  - WiFi, bluetooth, GPRS, 3G, 4G…

Sensors in Modern Smartphones

- Dual microphones (audio sensor)
- Dual cameras (image sensor)
- GPS (location sensor)
- Accelerometer and gyroscope (orientation sensor)
- Magnetometer (magnetic sensor)
- Motion sensor
- Ambient light sensor
- Proximity sensor
- Finger print sensor (identity sensor)
- Barometer (air pressure sensor)
- Altimeter (altitude sensor)

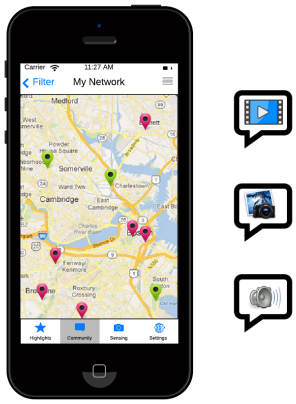
Remote Surveillance on iPhone

- Truly wide area communication – iPhone can be anywhere away from home
- Control appliances and electronic devices
- Live surveillance video feed
- Cost may incur on personal mobile data usage, such as 3G, 4G



Example of Social Sensing App

- Not compulsory to establish friend circles
- Location-aware imaging sharing
- Short data lives to achieve "live data"
- Categories: traffic, news, traffic, emergency
- Questions remain for the areas of applications



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Social Sensing

- Social sensing is a cutting-edge concept that takes advantage of both smartphone sensing and social network activities.
  - Still in research stage.
- A background reading paper is provided: *Reading/Smartphone Based Social Sensing*
- To understand social sensing, it is also essential to obtain knowledge of social networks.

Sociability

- **Sociability** is a metric that measures the strength of a user's connection to his/her social group.
  - In other words, it represents the quantity and quality of his/her relations with other users in the social network.
- This measurement can be derived based on based on network constraint.
- In a social network, the **network constraint** for a node quantifies the strength of the node's connectivity.
  - For any two persons in a social network, a person with lower network constraint value is considered to have higher strength in terms of connectivity.

Network Constraint

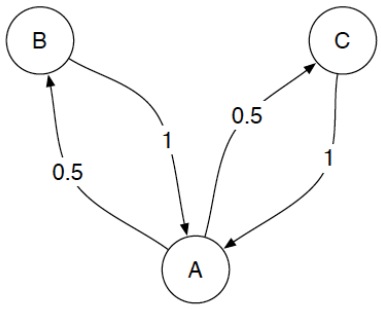
- The network constraint $\mathbf{N_i}$ for a node **i** in a social network is measured as:

$$N_i = \sum_j (p_{ij} + \sum_q p_{iq}p_{qj})^2, q \neq i, j; j \neq i$$

- where $\mathbf{p_{ij}}$ is the proportion of time **i** spent with **j**, i.e., the total time spent by **i** with **j** divided by the total time spent by **i** with all users in the network.

Example Scenario

- Assume that A spent 5 hours with B and 5 hours with C, and B and C did not spend any time with each other.
- The fraction of time A spent with B is 0.5 and with C is 0.5 and these are represented as weights in the graph. However, B has spent time only with A, therefore the weight of the edge (B,A) is one, similarly the weight of edge (C,A) is one too.
- The ranking with respect to decreasing order of sociability (or increasing order of network constraint) is: A(0.5), B(1.25), C(1.25). Since A distributes his/her time between two contacts, he/she is less constrained than B and C, therefore A is more sociable.



A is more sociable than B,C.

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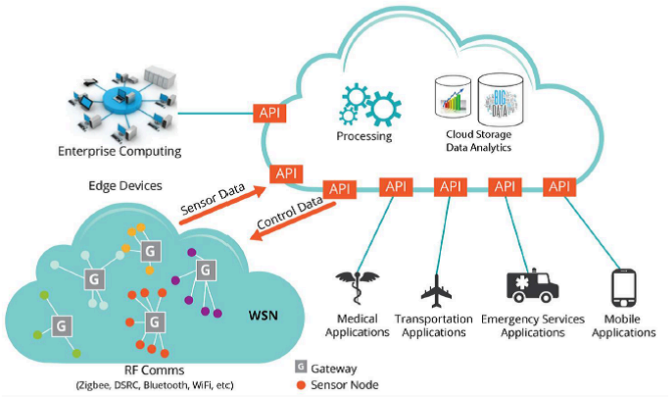
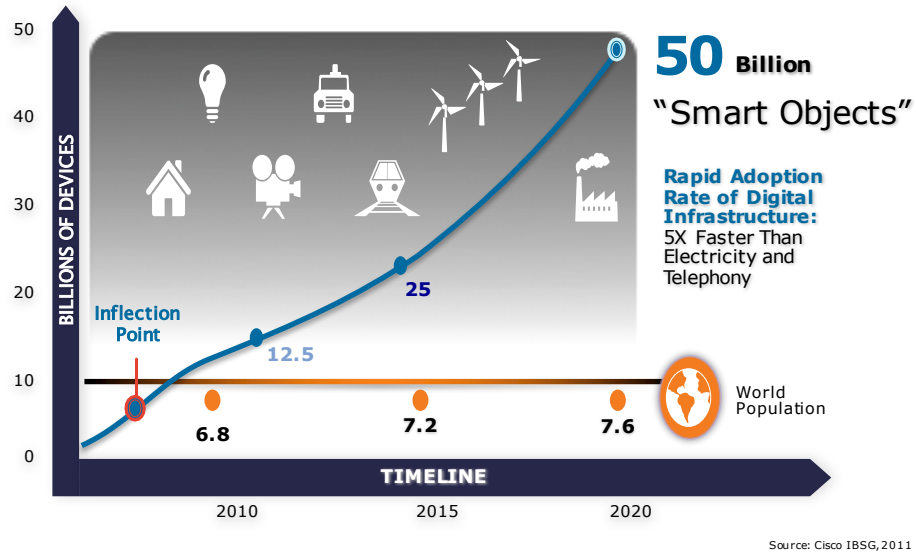
The Big Idea

- The Internet of Things is the intelligent connectivity of physical devices driving massive gains in efficiency, business growth, and quality of life.



IoT Is Here Now – and Growing!



50 Billion
"Smart Objects"

Rapid Adoption Rate of Digital Infrastructure:
5X Faster Than Electricity and Telephony

Source: Cisco IBSG, 2011

Push it further – Internet of Everything!

Networked Connection of People, Process, Data, and Things

Concept! Vision! Revolution!

IoT	Big Data	Cloud Computing

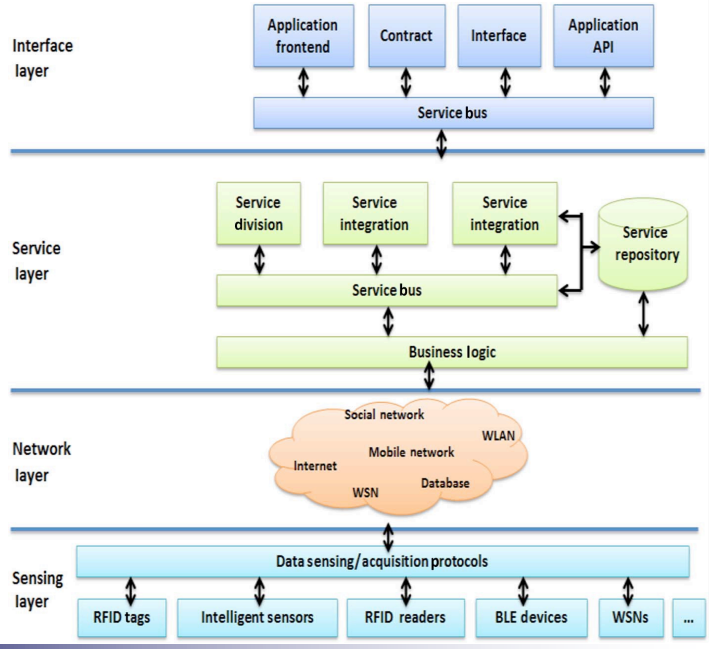
- Although these names are only a few years old, they have existed in our lives for decades.
- Probably more of a business revolution than a technological revolution.

Service Oriented Architecture for IoT

OSI Model
Application
Presentation
Session
Transport
Network
Data Link
Physical

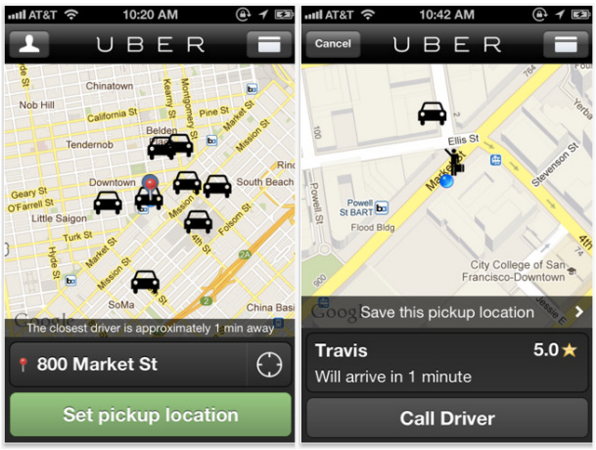
IoT Model
Interface Layer
Service Layer
Networking Layer
Sensing Layer

IoT Model



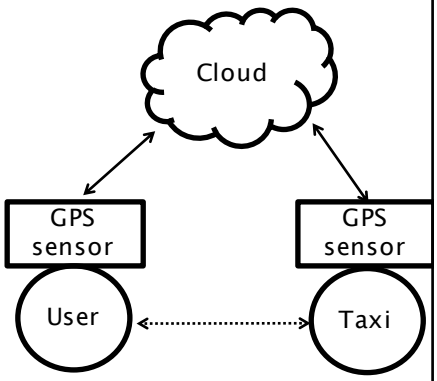
Case Study – Taxi Apps

- Successful and well-established business model
- Examples:
  - Uber
  - Didi Taxi
  - KuaiChe Taxi



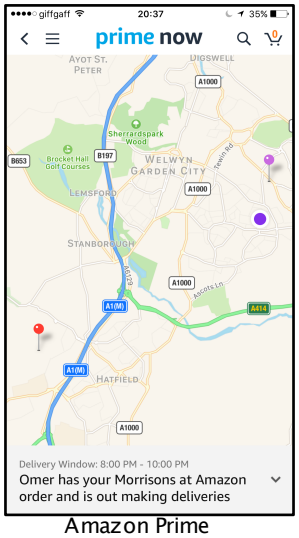
Internet of "Taxis"

1. User sends these data to the cloud.
   - GPS location of the source and the destination
   - Money matters, e.g. tip?
2. Cloud computes things.
3. A few things are selected.
4. One thing answers the request.
5. Direct contact between user and the thing in the app
6. Service begins.
7. Service monitoring.
8. Bill.



Case Study – Retail Delivery

- Using IoT in the logistics domain is one of the earliest ideas of application, and it is still a primary category of service.
- As simple as this can be in terms of technical implementation, the user experience still major improvement.
  - Again – IoT is a business war! Service providers have to think about the business worth first.

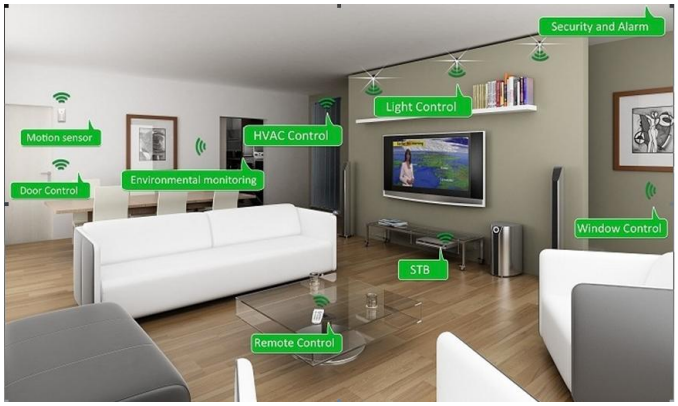


Amazon Prime

Meituan

Case Study – Smart Home

- There is definitely a growing need for smart home facilities in the market.
- The current bottleneck is the underlying communication technology for transmitting real-time surveillance videos. Hopefully 5G will solve it.



Questions?

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