OBJECT IDENTIFICATION, LOCALIZATION AND MOBILE COMPUTING TIME SERIES

Material

- Chapter 6 of Handbook
- Colab NB6-formats
- Datasets

https://www.dropbox.com/sh/ww92mqe6fp0vrfo/AABVDAOIHugWHMse-8GmPq6Na?dl=0

About object ids and positions

- Object identification technology
- Localization technology
- Time series

Object identification technology

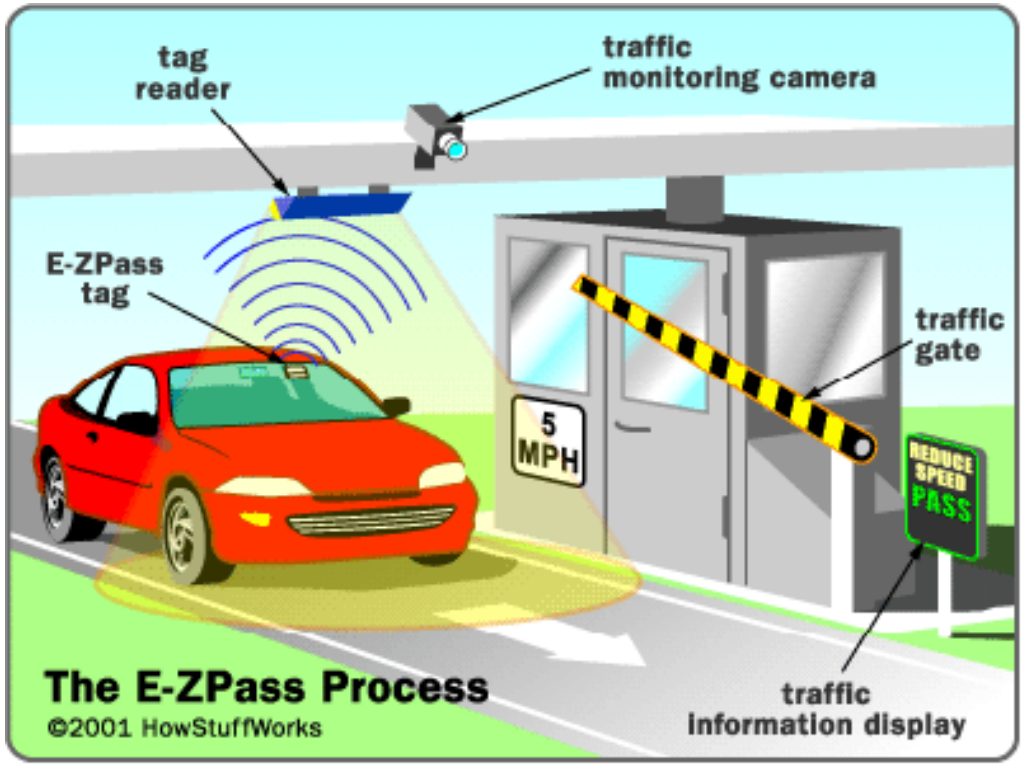
Identification Examples

- Bar Codes
- License Plates
- Social Security Numbers / Codice Fiscale
- Student ID
- Serial Numbers
- Car Keys
- Database Keys

The problem of object identification

- Associate an id to an object
  - Eg car plate, a point on a map (coordinates of a fixed object), …
- Associate information to an object
  - Eg identity of the owner, the state of a device , …
  - Static, dynamic
- Problem:
  - How to identify a car passing by a toll gate
  - Automatic identification: transmitters and receivers

Automated Toll Collection



Identifiers - basics

RECEIVER

Network protocol

Distance (frequency)

OBJECT

Id

Id+info

Fixed info

ability to process info (microchip)

Identifiers

- Mobility
- Identifiers, authentication
- IoT
  - RFID technology
  - Epassports

  - Smart objects
  - Other technologies: NFC, QR codes
  - Social Media, social networks

What is RFID?

- Radio Frequency Identification
- The use of radio frequency tags to identify real objects.
- Provides an ID

What does it mean to identify something?

How Does RFID Work?

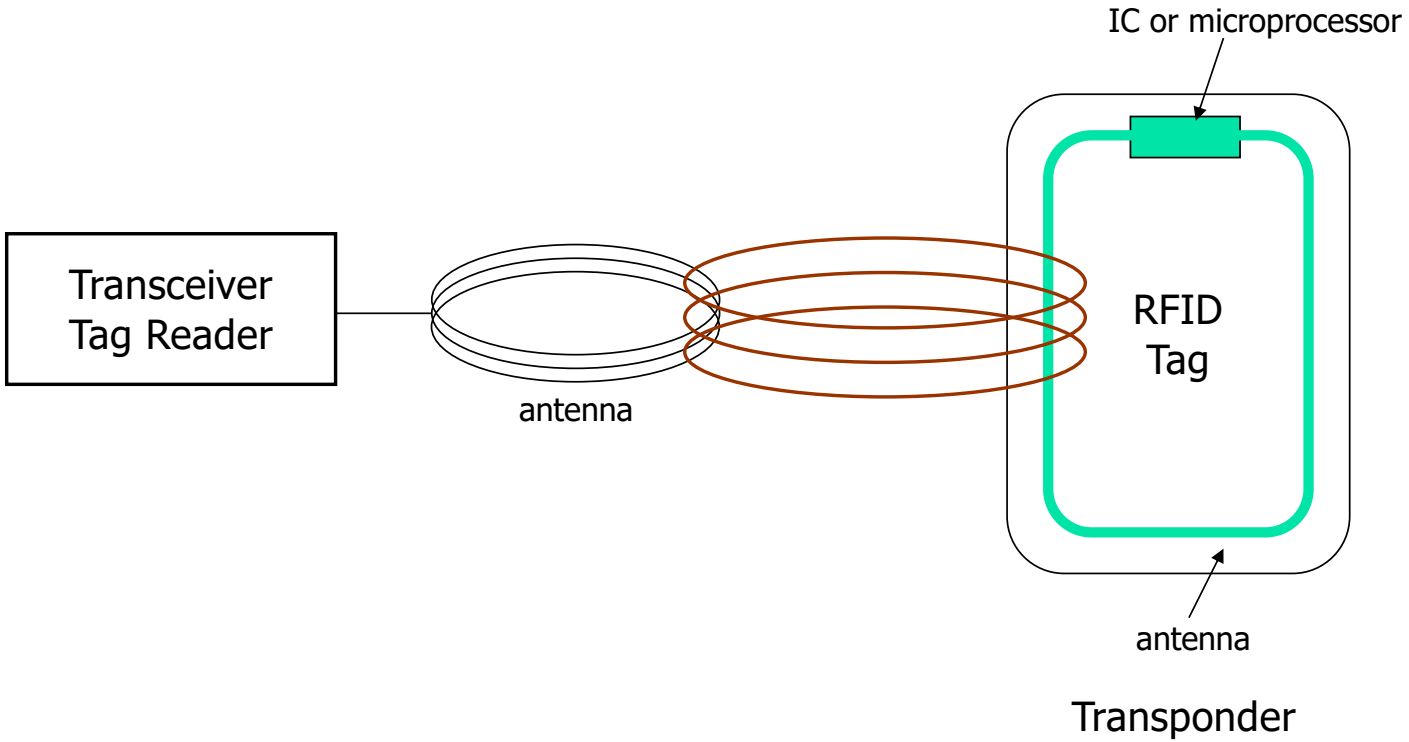
- 3 Components
  - Transceiver – Tag Reader
  - Transponder – RFID tag
  - Antennas

Types of Tags

- Passive Tags
  - No battery
  - Low cost
- Active Tags
  - Battery – must be replaced
  - Longer range
  - High cost

RFID Hardware – passive tags

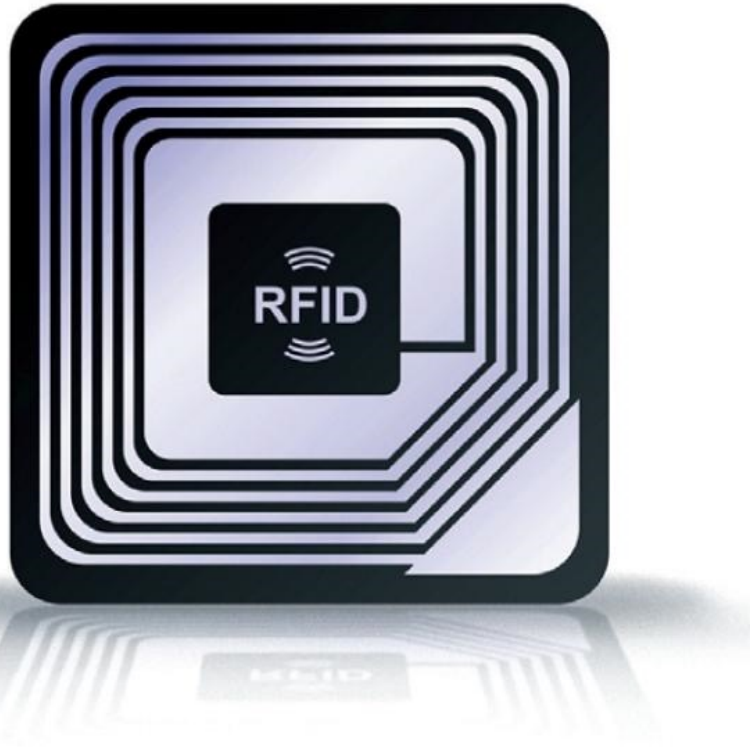
Magnetic / Inductive Coupling



Passive tags

- No Internal power supply
- Obtain operating power generated from the reader.
- Small in size, lighter and less expensive.
- Shorter read range.
- Embedded in a sticker or under the skin

Internet of Things – Radio Frequency identification



Source: http://www.wirelessvisionme.com

Passive tags

- No Internal power supply
- Obtain operating power generated from the reader.
- Small in size, lighter and less expensive.
- Shorter read range.
- Embedded in a sticker or under the skin

Who's got an RFID tag with them right now?

Active tags

- Powered by internal battery
- More reliable than passive tags due to the ability for active tags to conduct a "session" with a reader
- More memory size up to 1 MB.
- Long read range.
- Bigger size, more expensive and limited operational lifetime.

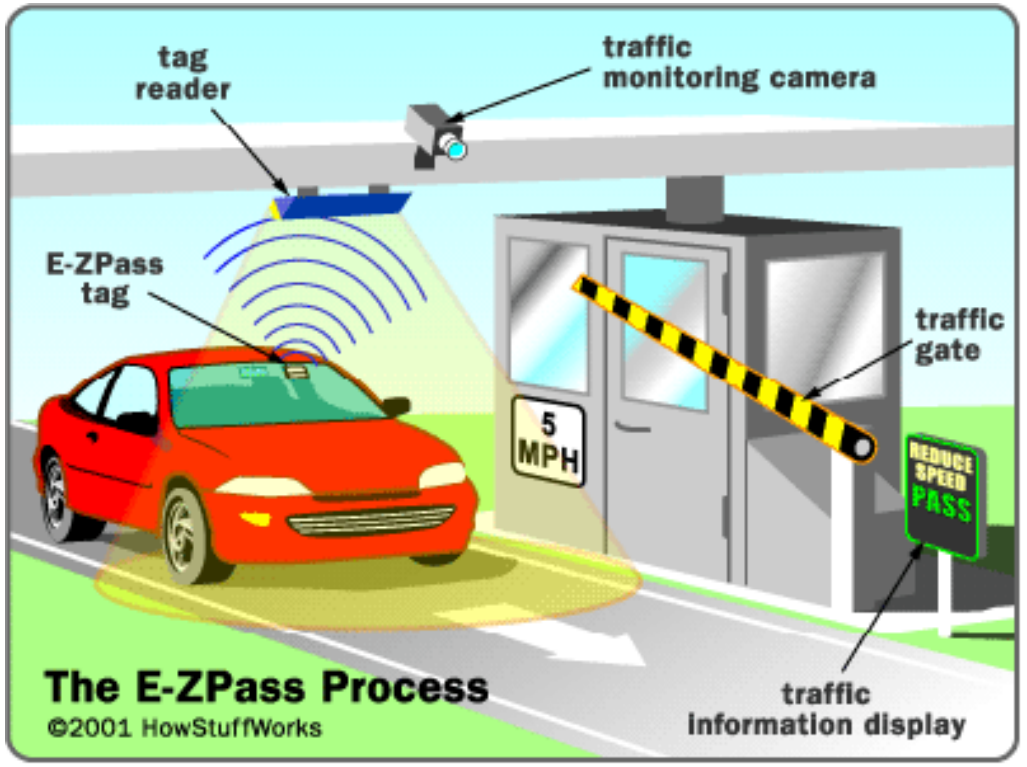
Types of Tags

- Read Only
  - factory programmed
  - usually chipless
- Read / Write
  - on-board memory
  - can save data
  - can change ID
  - higher cost

Frequency Ranges

- Low – 100-500 kHz
  - short range, low data rate, cost, & power
- Intermediate – 10-16 MHz
  - medium range and data rate
- High – 850-950 MHz & 2.4-5.8GHz
  - large range, high cost, high data rate
  - needs line of sight

Automated Toll Collection



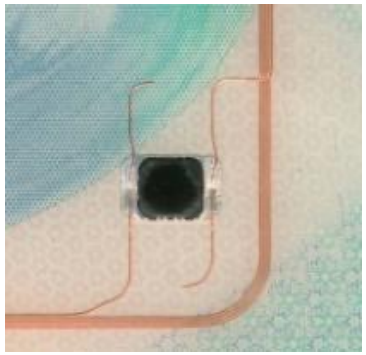
Supply chain vs Passport tags

- Supply Chain RFID tags:
  - simple, cheap,
  - no support for cryptography,
  - single identifier

- Passport RFID tags:
  - shorter intended read range,
  - tamper resistant,
  - Cryptography (next lectures)

E-PASSPORT

Machine-readable zone



RFID

From Erik Poll

Digital Security Group

Radboud University Nijmegen

Discussion on epassports

- Which information?
- Privacy?
- Risks?

- Will be analyzed in the security part of the course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NFC Near Field Communication

- Like other "proximity card" technologies, NFC employs **electromagnetic induction** between two loop antennas when NFC-enabled devices— for example a smartphone and a printer— exchange information, operating within the globally available unlicensed **radio frequency ISM band of 13.56 MHz** on ISO/IEC 18000-3 air interface at rates ranging from 106 to 424 kbit/s.

- **Range** around 10 cm or less

- Each *full NFC device* can work in three modes:
  - **NFC card emulation**—enables NFC-enabled devices such as smartphones to act like smart cards, allowing users to perform transactions such as payment or ticketing.
  - **NFC reader/writer**—enables NFC-enabled devices to read information stored on inexpensive NFC tags embedded in labels or smart posters.
  - **NFC peer-to-peer**—enables two NFC-enabled devices to communicate with each other to exchange information in an ad hoc fashion.
- NFC tags are passive data stores that can be read, and under some circumstances written to, by an NFC device.


Access control
Mobile payments
Loyalty programs
In-store marketing
10:48
NFC
RFID
Location-based services
Targeted marketing
Information exchange
Social networks

Mobility and location sensors

- How to localize a car?
  - Ex 1: toll control
  - Ex 2: position of the car at any time

Localization technology

- Tranceivers
- Outdoors
  - GPS: Global Positioning System
    - Satellite-based positioning system (US)
- Indoors
  - Beacons
- QR codes

Mobile computing

- Mainly enabled by two distinct technology developments:
  - the development of mobile computing devices
  - the development of wireless networks

- Has caused a disconnection of computing and internet access from fixed work places, giving way to the always-and-everywhere-connected paradigm

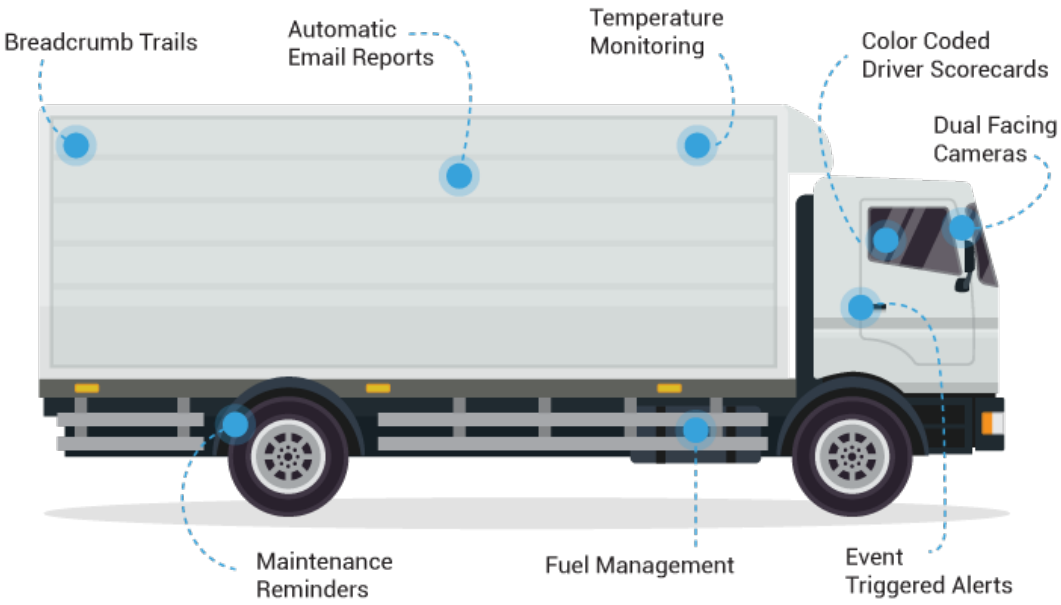
Contemporary Hardware Platform Trends

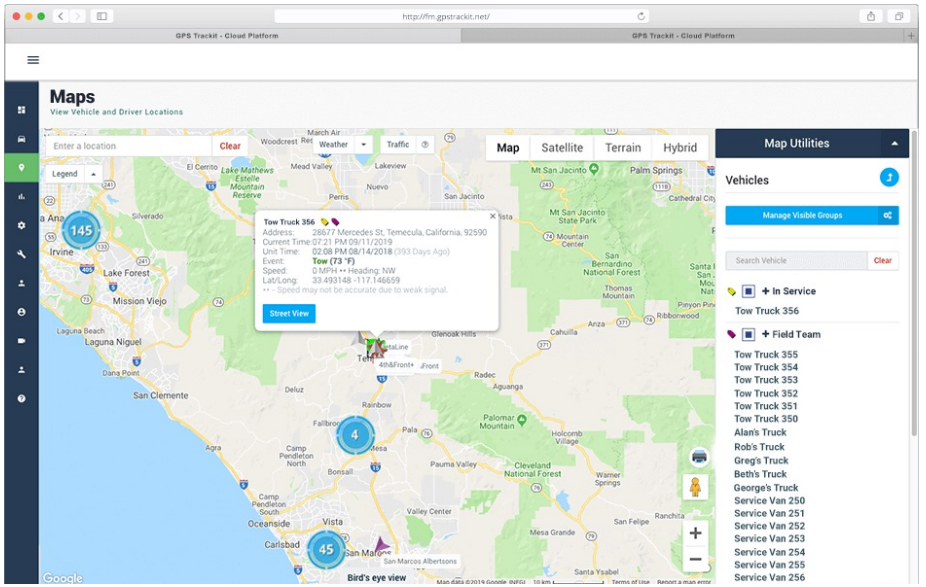
- **The mobile digital platform**
  - **Cell phones, smartphones (iPhone, Android)**
    - Data transmission, Web surfing, e-mail, social media, and IM duties
  - **Tablets (iPad)**
  - **Networked e-readers (Kindle)**

Fleet management

An example (to study)

- https://www.verizonconnect.com/solutions/gps-fleet-tracking-software/
- Location: GPS tracking





Location sensors

Indoors

- Beacons

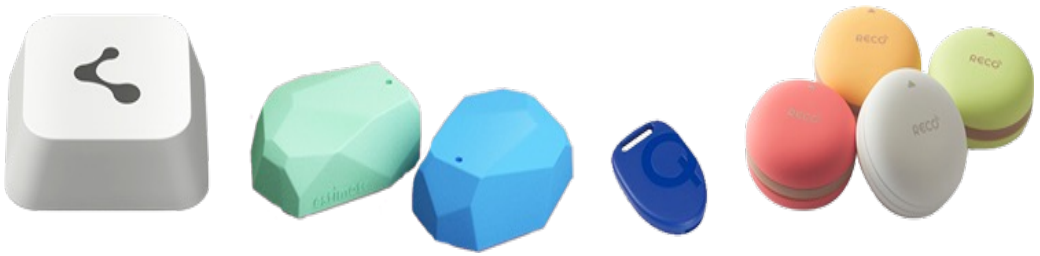
QR codes

What are the beacons?

- Beacons are small, battery-powered, **always-on** devices that use **BLE** (Bluetooth Low Energy) technology to transmit signals to devices, such as smartphones and tablets, within a range of about 100 meters.

  BLE beacons are **1-way hardware transmitters** aimed at detecting nearby devices in order to send them messages; while the target devices do not send information back to the beacons.

- to transmit a universally unique identifier
- tags' regular signals



What is BLE?

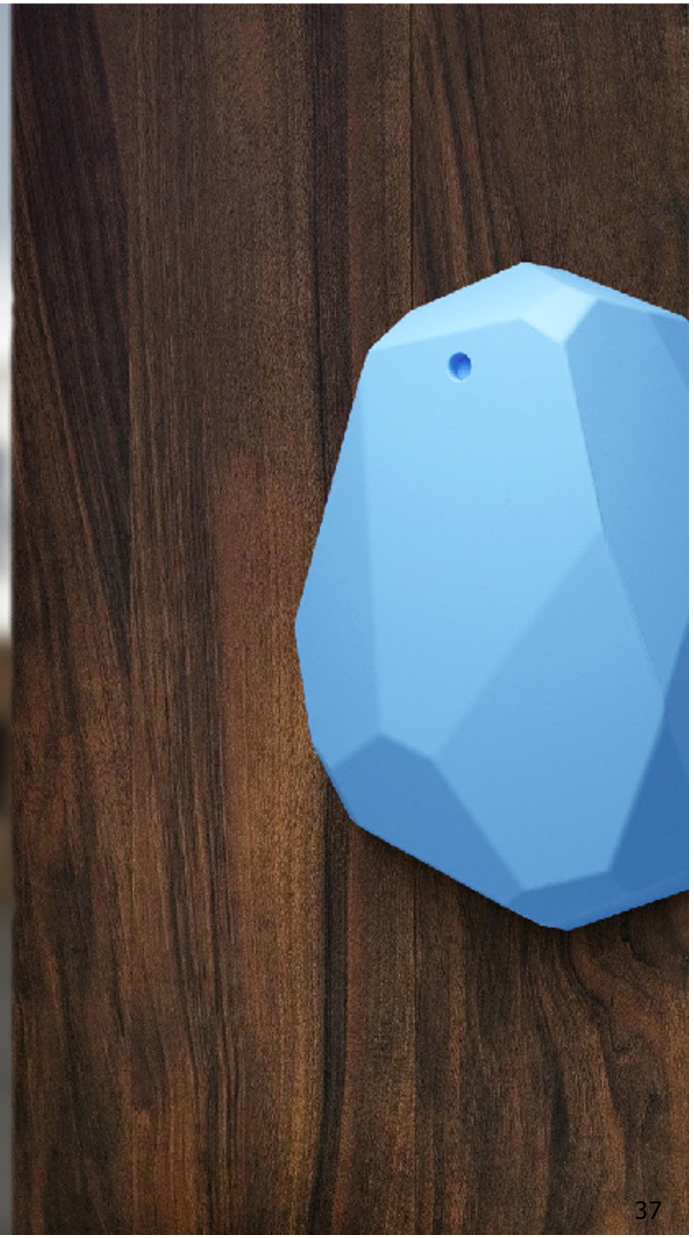
Bluetooth Low Energy is a wireless personal area network technology used for transmitting data over **short distances** and it is designed for **low energy consumption** and cost.

BLE VS Classic Bluetooth

Power Consumption: BLE has low energy requirements. It can last up to 3 years on a single coin cell battery.

Lower Cost: BLE is 60-80% cheaper than traditional Bluetooth.

Application: BLE is ideal for simple applications requiring small periodic transfers of data



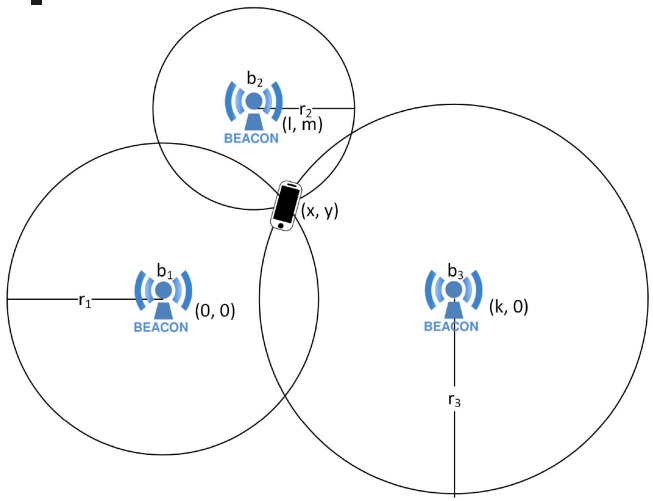


Fig. 1. Example of trilateration with three beacons, b_1, b_2, and b_3 in known locations, (0, 0), (l, m), and (k, 0), respectively, are the transmitters and a smartphone at the intersection, (x, y), as the receiver.

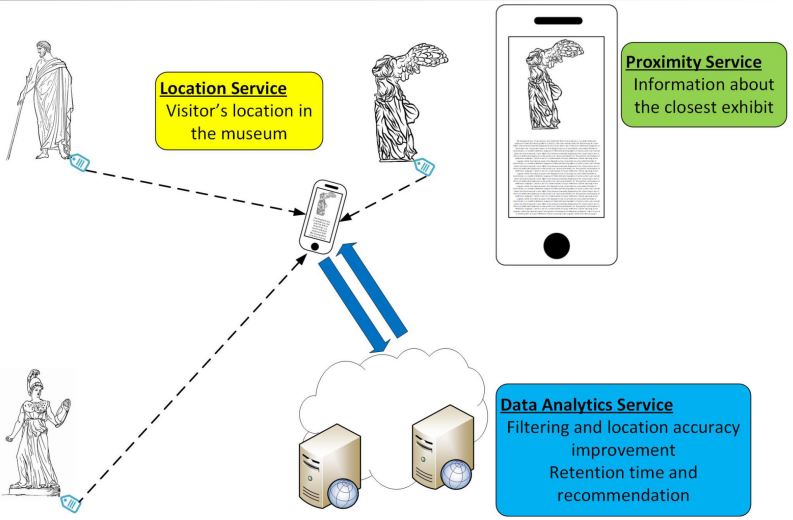
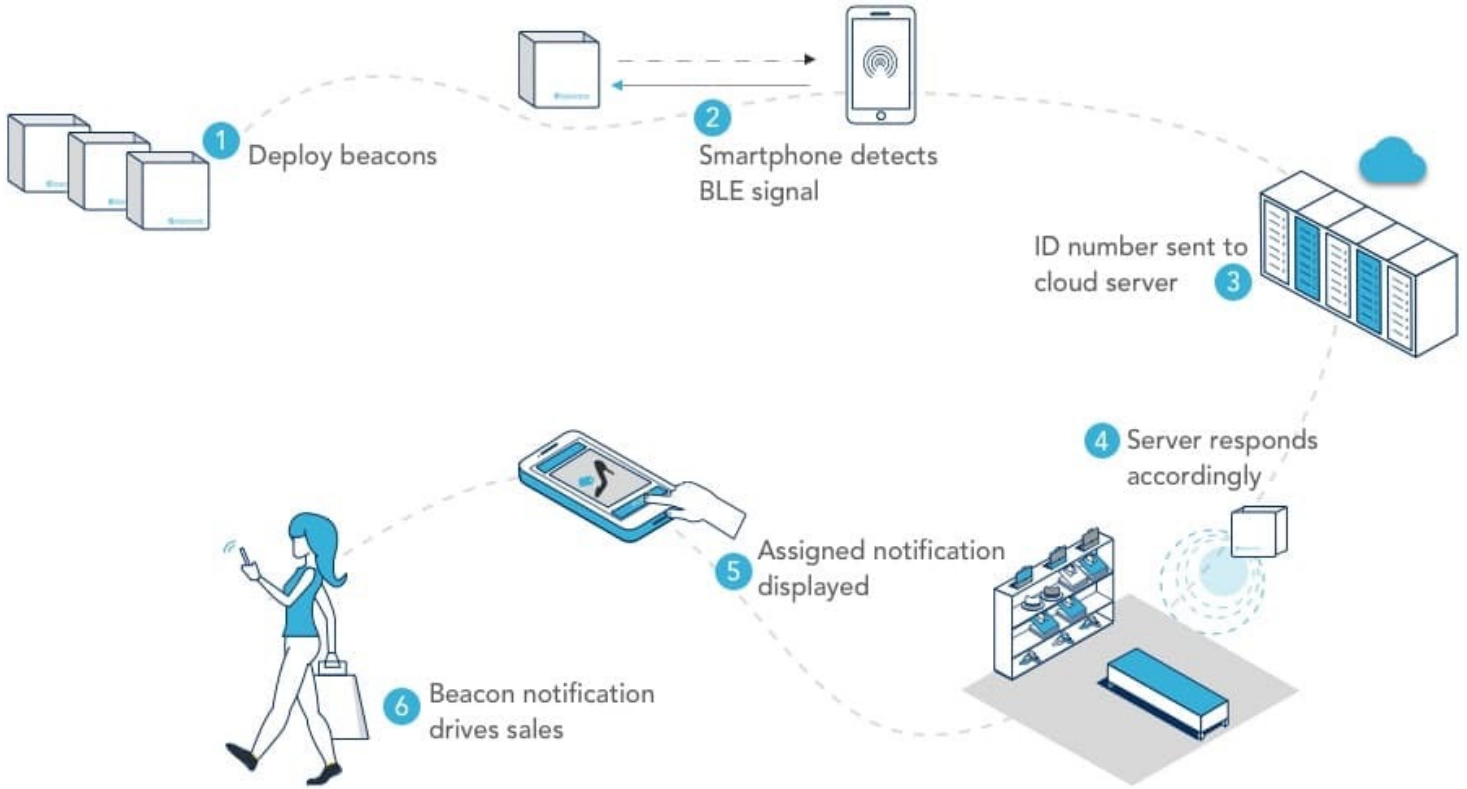


Fig. 2. Illustration of the system services. There are three main services—the location service, the proximity service, and the data analytics service.

While the visitor is in the proximity of the exhibit,
the application records the retention time and the beacon ID.
If there is a Wi-Fi connection, these data are forwarded to the control room
where the recommendation system is running.
If there is no Wi-Fi connection, the application stores
all the information locally and forwards them to the server
the next time there is a wireless connection.

(Combined with the Mobile Application Management model)

How do beacons work?

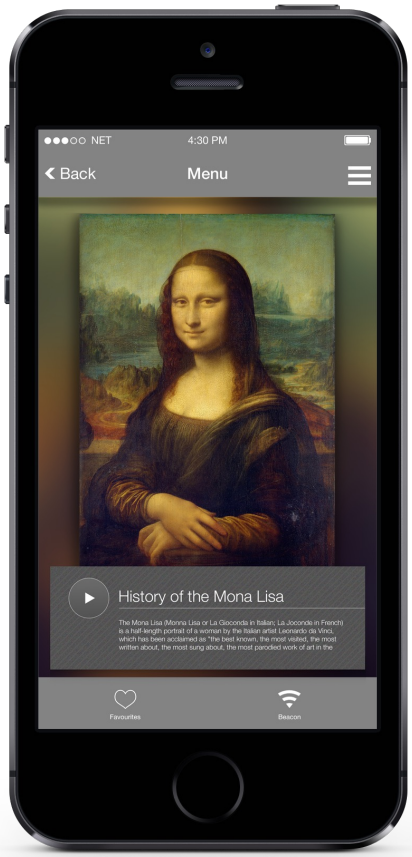


Museums applications

- https://smartbeacon.it/

Applications

- Gamify
- Track visitor
- Self guided tours



QR codes (quick respond codes)

QR codes often contain data for a locator, identifier, or tracker that points to a website or application

Scanned with a smartphone, it provides a way to access a brand's website more quickly than by manually entering a URL - "touchless" system to display information

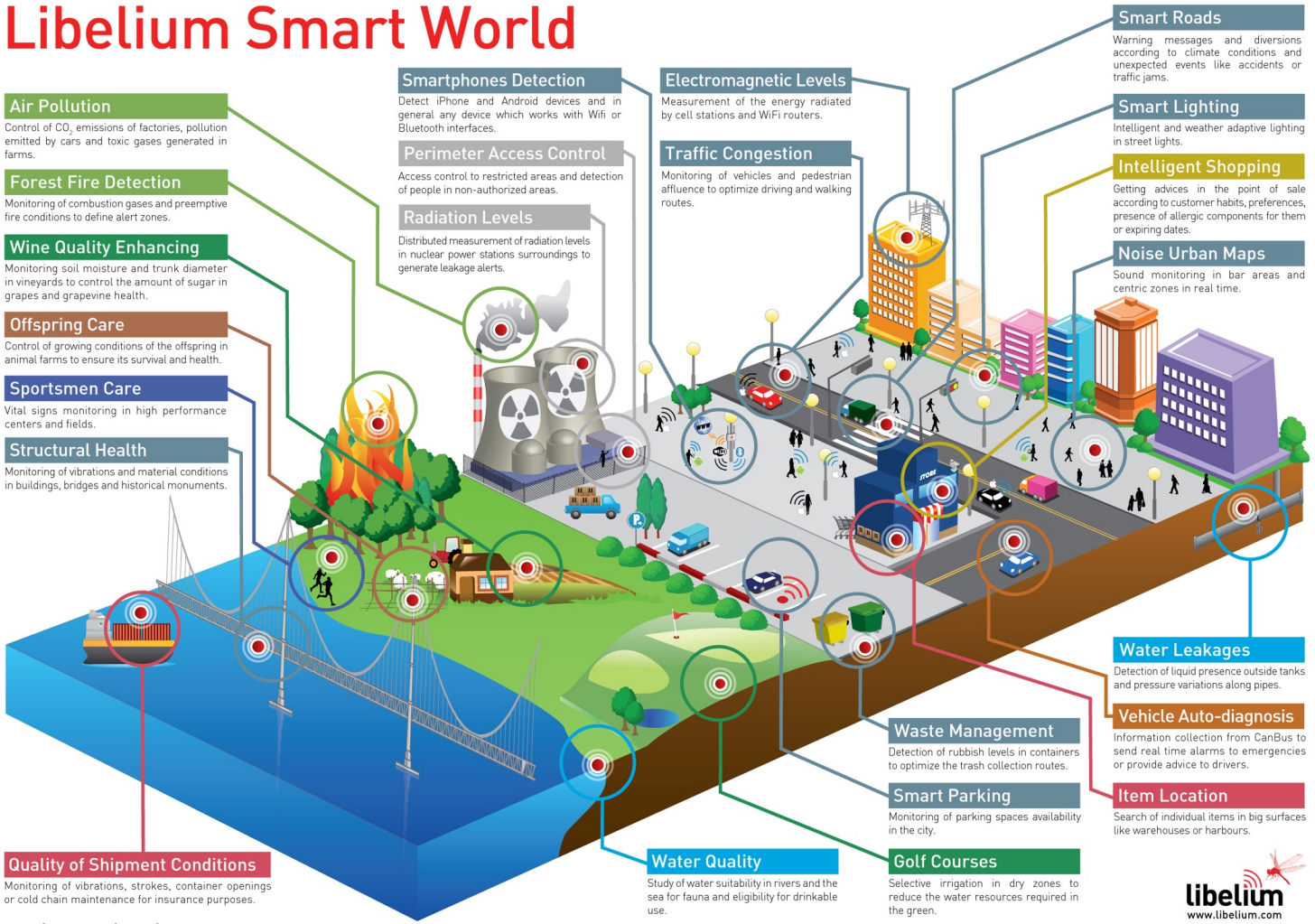
Dynamic QR codes

multilingual

https://www.beaconstac.com/qr-code-menu-restaurants

IoT and managed objects

http://www.libelium.com/

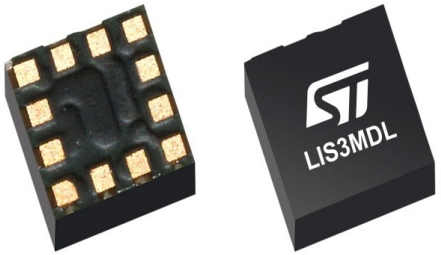


From Libelium's web site
Sensor nodes collecting information

Ambient Sensors

- Accelerometer, Gyroscope, Magnetometer, Barometer, Thermometer, Relative Humidity Sensor, Light Sensor etc.

Accelerometer



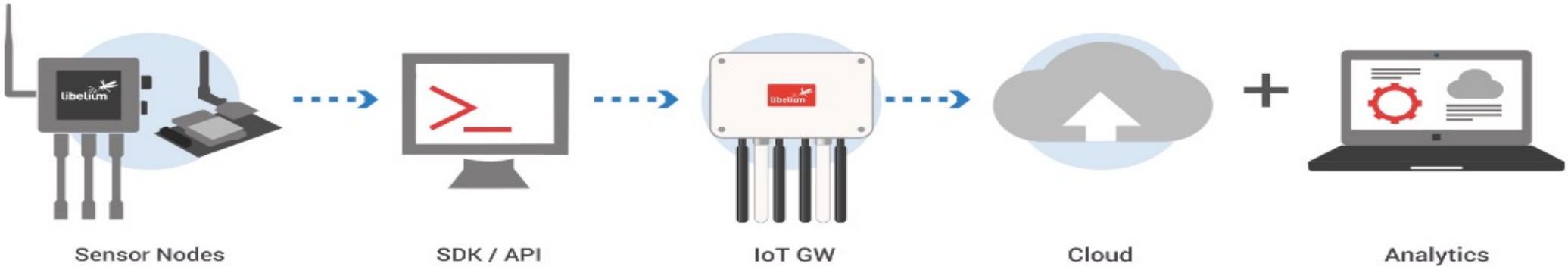
Gyroscope

Swadhin Pradhan
UT Reading group slides

Gateway to the network

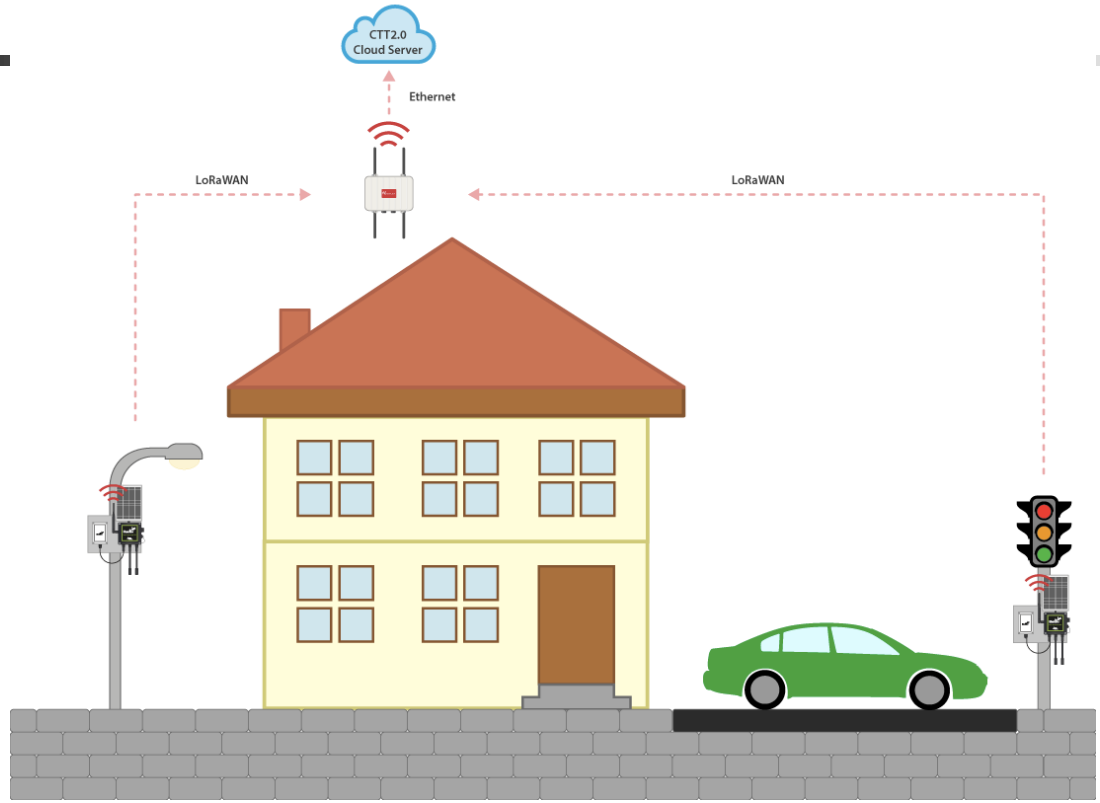
Multiple radio options to communicate through a gateway or directly to the cloud

With a gateway to Internet



http://www.libelium.com/partners-ecosystem/

CTT 2 Project



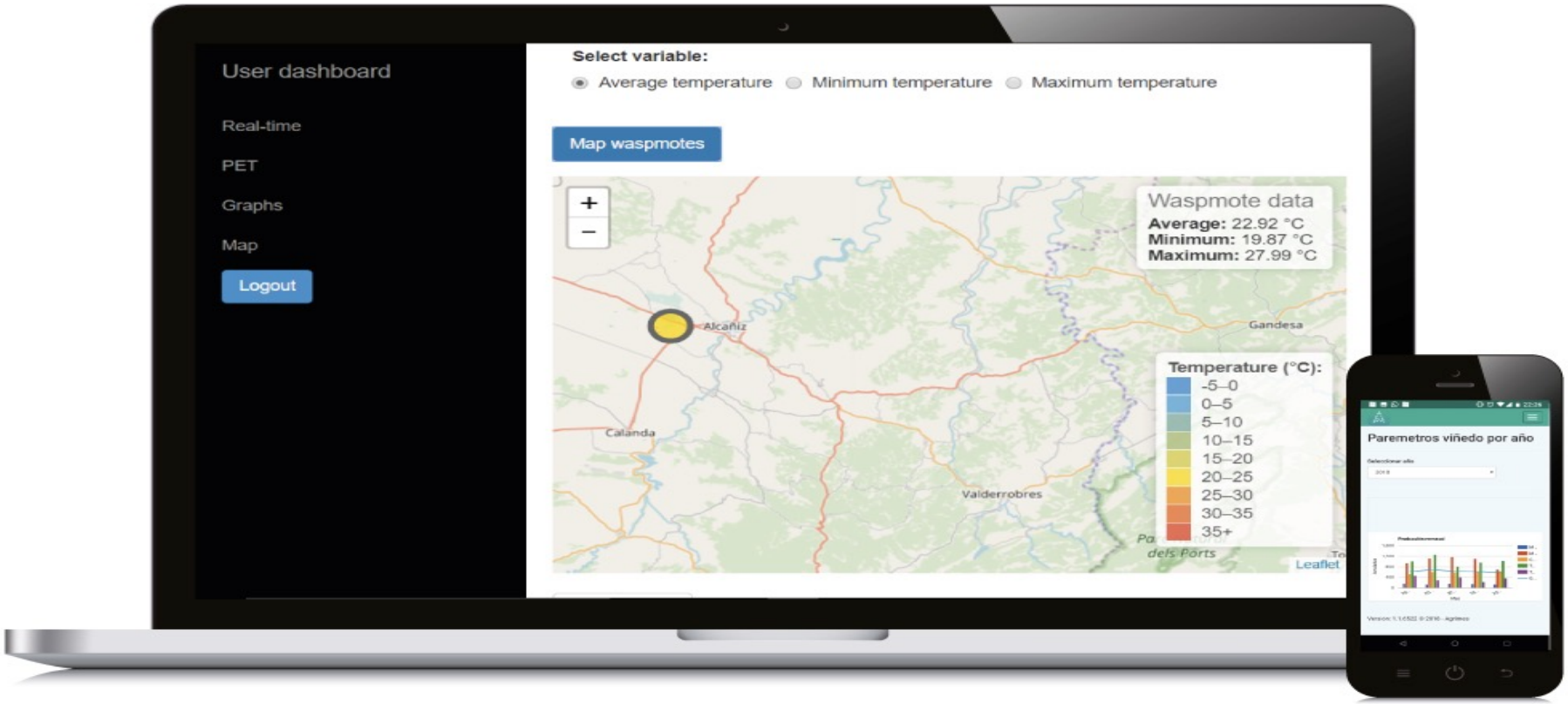
the sensors installed have been: carbon dioxide (CO_2), nitric oxide (NO), particle matter – dust (PM1, PM2.5 and PM10), temperature, pressure and humidity.

Smart agriculture

- Libelium Waspmote Plug & Sense! Smart Agriculture at Pago Aylés Winery
- The collated data is
  - sent by 4G directly to the
  - Microsoft Azure cloud.

- For this specific project, the winery has chosen the Agrimés solution, a web application that works with Microsoft's Azure cloud. With this application, developed by remOT Technologies, the user can view the data in a values table or chart format and compare the same parameters on different dates.

Agrimés app


User dashboard
Real-time
PET
Graphs
Map
Logout
Select variable:
Average temperature
Minimum temperature
Maximum temperature
Map waspmotes
Waspmote data
Average: 22.92 °C
Minimum: 19.87 °C
Maximum: 27.99 °C
Alcañiz
Calanda
Valderrobres
Gandesa
Temperature (°C):
-5–0
0–5
5–10
10–15
15–20
20–25
25–30
30–35
35+
Leaflet
Parametros viñedo por año

Internet of Things Managed Objects

the network of physical objects—devices, vehicles, buildings and any item embedded with electronics, software, sensors, and network connectivity—that enables these objects to collect and exchange data

Measurement Values for Refrigerator Power Consumption converted into JSON.

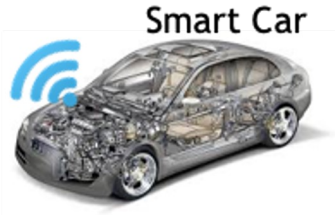

```
{
   "XML": { "version": 1.0, "encoding": "UTF-8" },
"Comment": " Example of a simple "odf" structure for a refrigerator. ",
"Objects": {
   "xmlns:xsi": "http://www.w3.org/2001/XMLSchema-instance",
   "xsi:noNamespaceSchemaLocation": "odf.xsd",
   "Object": {
      "type": "Refrigerator Assembly Product",
      "id": "SmartFridge22334411",
      "InfoItem": {
         "name": "Consumed Electrical Power Measure",
         "description": "Power consumption values with timestamp.",
         "value": [
            {
               "dateTime": "2001-10-26T15:33:21",
               "Text": 15.5
            }, {
               "dateTime": "2001-10-26T15:33:50",
               "Text": 15.7
            }, {
               "dateTime": "2001-10-26T15:34:15",
```


```
{
    "dateTime": "2001-10-26T15:33:21",
    "Text": 15.5
}, {
    "dateTime": "2001-10-26T15:33:50",
    "Text": 15.7
}, {
    "dateTime": "2001-10-26T15:34:15",
    "Text": 1.3
}, {
    "dateTime": "2001-10-26T15:34:35",
    "Text": 1.5
}, {
    "dateTime": "2001-10-26T15:34:52",
    "Text": 15.3
}
```

The importance of time series analysis

Smart Cities

Massive production of time-series data over time



Smart Home/Building

Time series analysis aims at extracting meaningful summary and statistical information from points arranged in chronological order

Source: Roveri-Falcetta

Wrangling time-series data (aka garbage in, garbage out)

Source: Roveri-Falcetta

What to do with that?

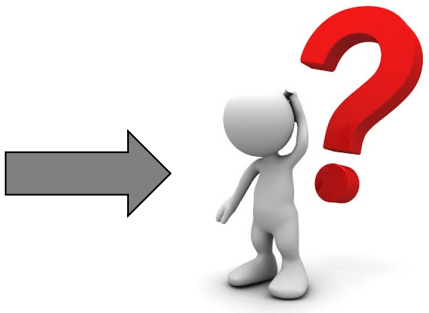
- Timestamping Troubles
- Handling missing data
- Changing the frequency of the time series
- Smoothing data
- Addressing seasonality in data

Source: Roveri-Falcetta

1) Timestamping Troubles

- Timestamps are quite helpful for time series analysis.
- From timestamps, we can extrapolate a number of interesting features, such as time of day or day of the week.
- But.. what process generated the timestamp, how, and when?
  - Often an event happening is not coincident with an event being recorded
  - E.g., the sample meal diary from a weight loss app

Time	Intake
Mon, April 7, 11:14:32	pancakes
Mon, April 7, 11:14:32	sandwich
Mon, April 7, 11:14:32	pizza



Did the user specify this time or was it automatically created? Does the interface perhaps offer an automatic time that the user can adjust or choose to ignore? Where in the world was it 11:14?

Source: Roveri-Falcetta

2) Handling missing data

- Missing data is surprisingly common in real-world datasets (e.g., communication problems, faults in sensor/actuators, software bugs, etc..)
- How to deal with that?
  - **"Global" filling methods**
    - When we fill in missing data based on observations about the entire data set.
  - **"Local" filling methods**
    - When we use neighboring data points to estimate the missing value.
  - **Deletion of affected time periods**
    - When we choose not to use time periods that have missing data at all.