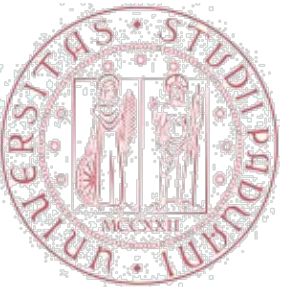


DIPARTIMENTO
DI INGEGNERIA
DELL'INFORMAZIONE

IoT for Smart Cities

Part C: Experimental activities

Andrea Zanella

zanella@dei.unipd.it

SIGnals processing &
NETworking research group

Padova
municipality

PADOVA SMART CITY

Andrea Zanella

Outline

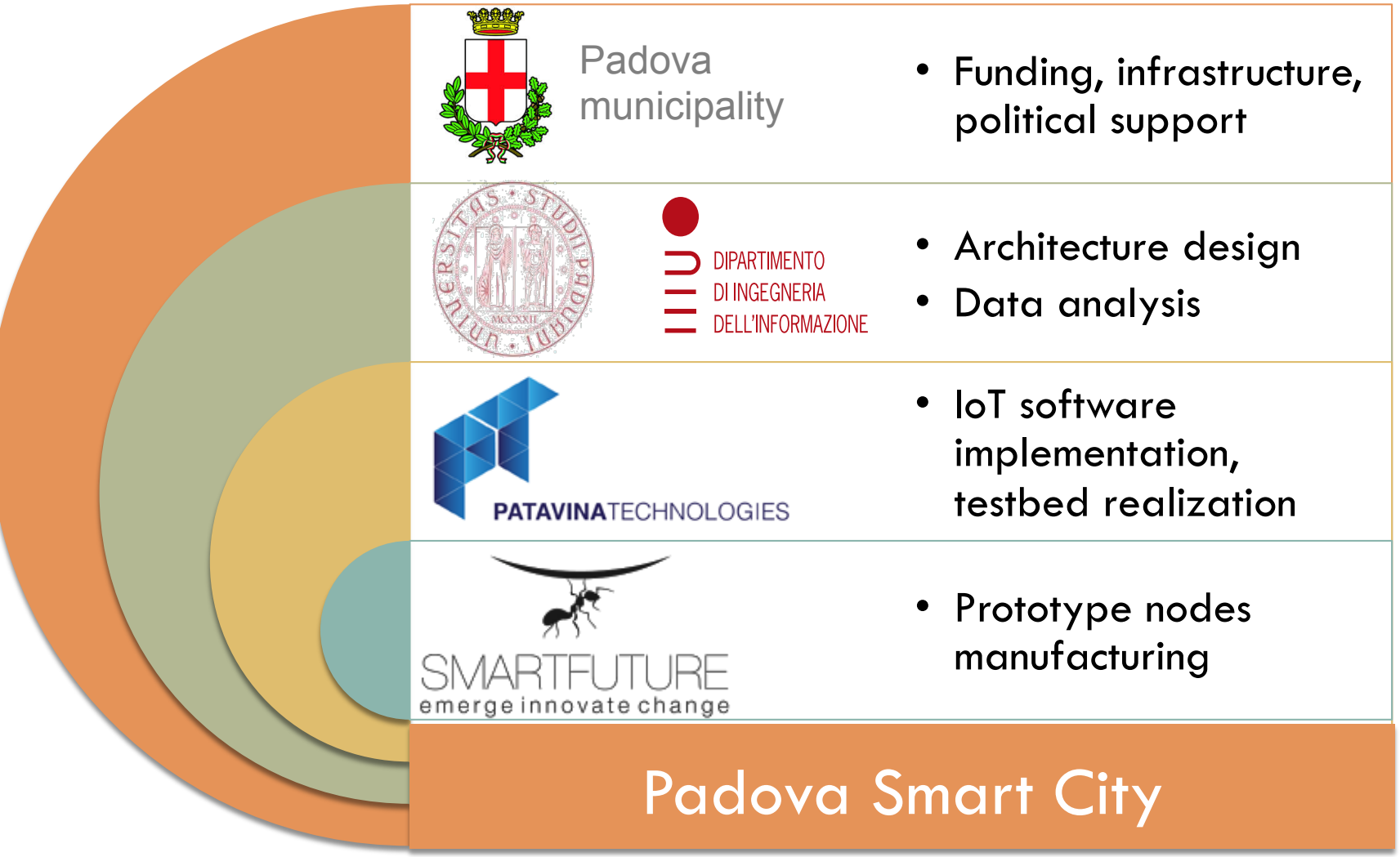
- Urban IoT: the Smart City enabling technology
- Padova Smart City
  - system architecture
  - data analysis
- Conclusions

Smart Cities & IoT

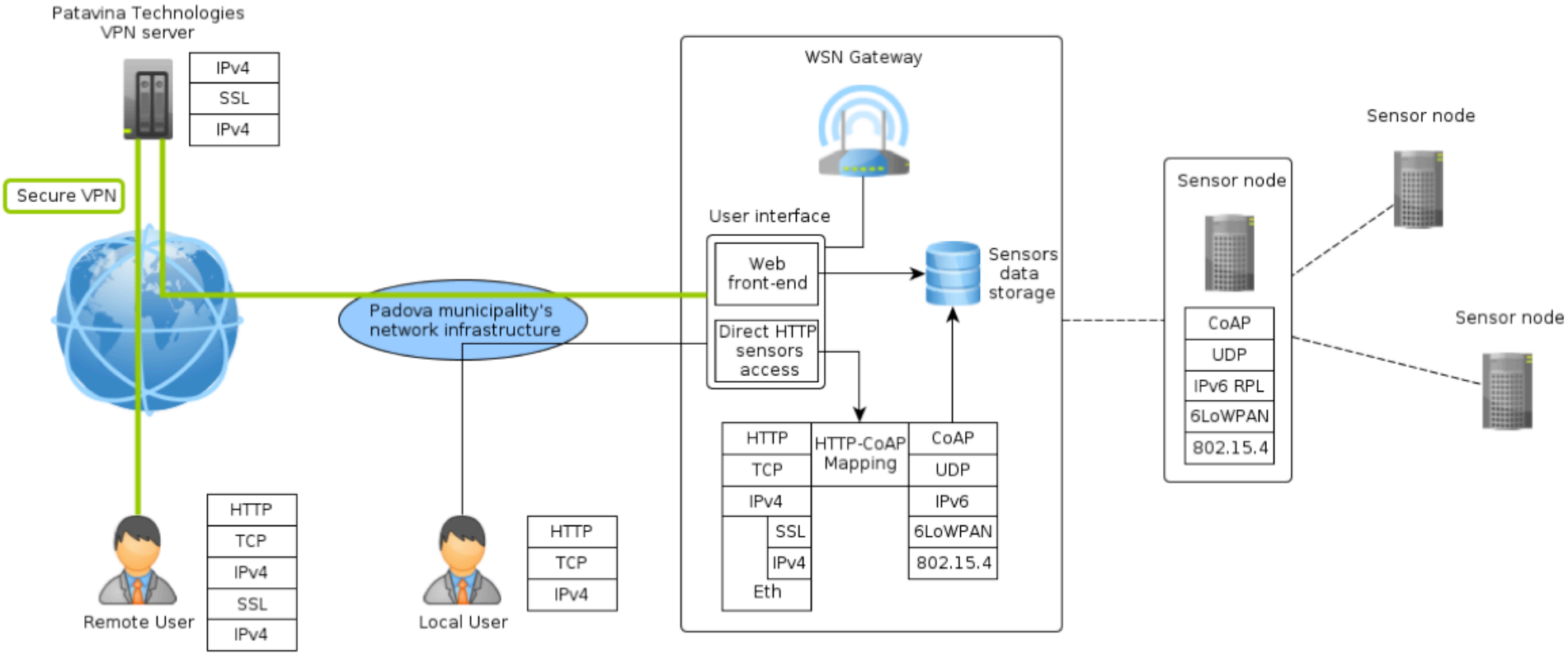
- Making cities smarter requires a platform for
  - Collecting heterogeneous data in a seamless manner
  - Accessing remotely devices spread over the city
  - Providing easy/public access to collected data
  - Extracting useful information from huge amounts of data

- Urban Internet of Things is what we need!
  - *Padova Smart City* (PSC): a proof-of-concept urban IoT realized in the city of Padova (Italy)

PSC: the players



PSC: architecture



The software architecture

- On sensor nodes
  - CoAP: Constrained Application Protocol
    - Allows for web-like interaction with nodes
  - RPL: Routing Protocol for Low-Power and Lossy Networks
    - Energy saving routing protocol, explicitly designed for nodes with low nodes mobility
  - 6LowPAN
    - Energy efficient implementation of IPv6 network protocol
  - Low Power Listening (LPL)
    - Nodes sleep most of the time: wake up every second to listen to channel

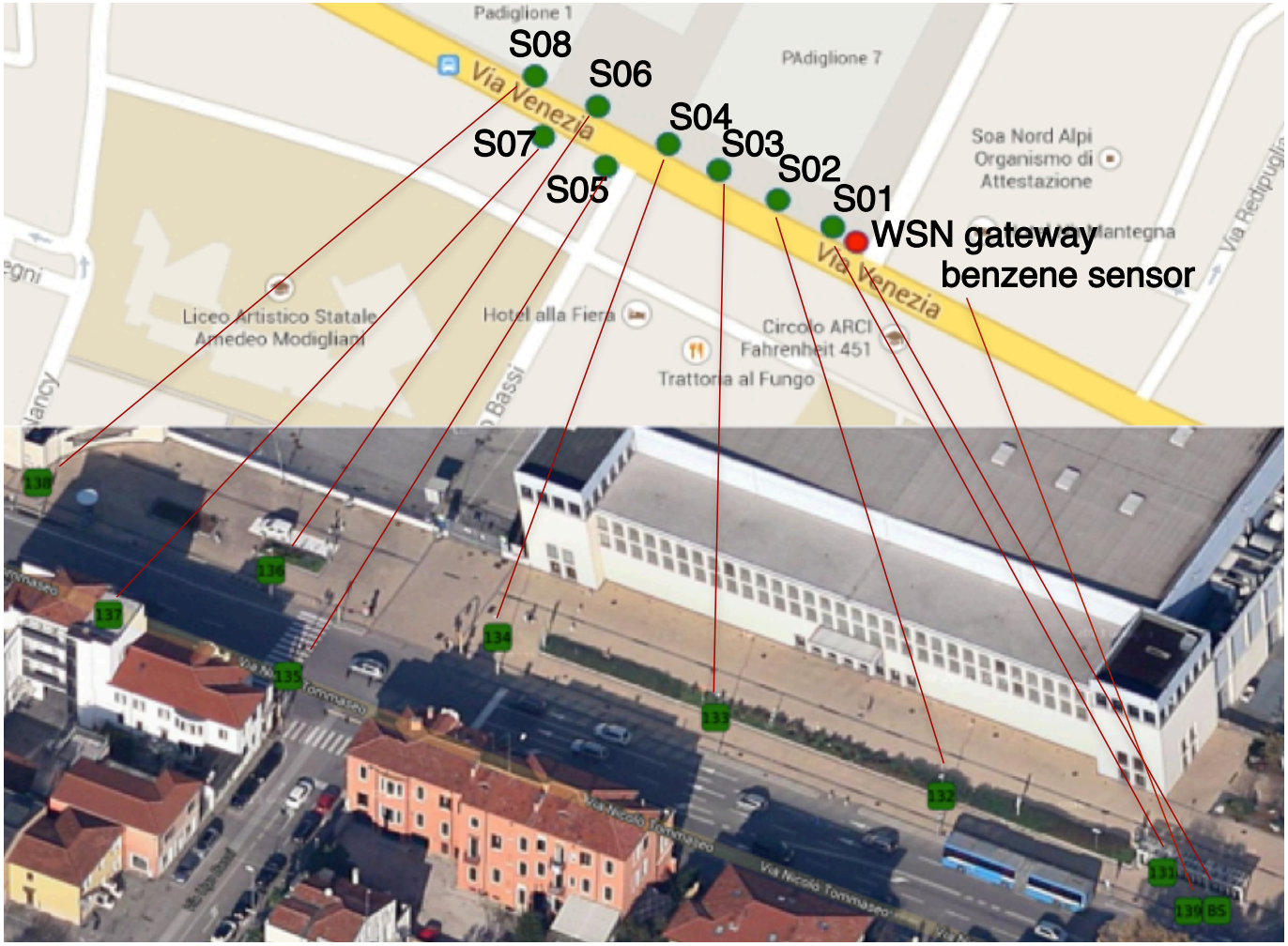
Target application: monitoring public lighting system

- WSN gateway placed inside the switch box that controls the monitored streetlights
  - A low-voltage DC power socket is available in the box
- 8 sensor nodes equipped with multiple sensors
  - light, temperature, humidity readings
  - Mounted close to the bulbs of streetlight poles
    - Battery-pack powered
- One sensor node equipped with benzene sensor
  - placed inside the switch, power by DC source

Nodes placement

Sensor node protected by transparent plastic shield that permits air circulation

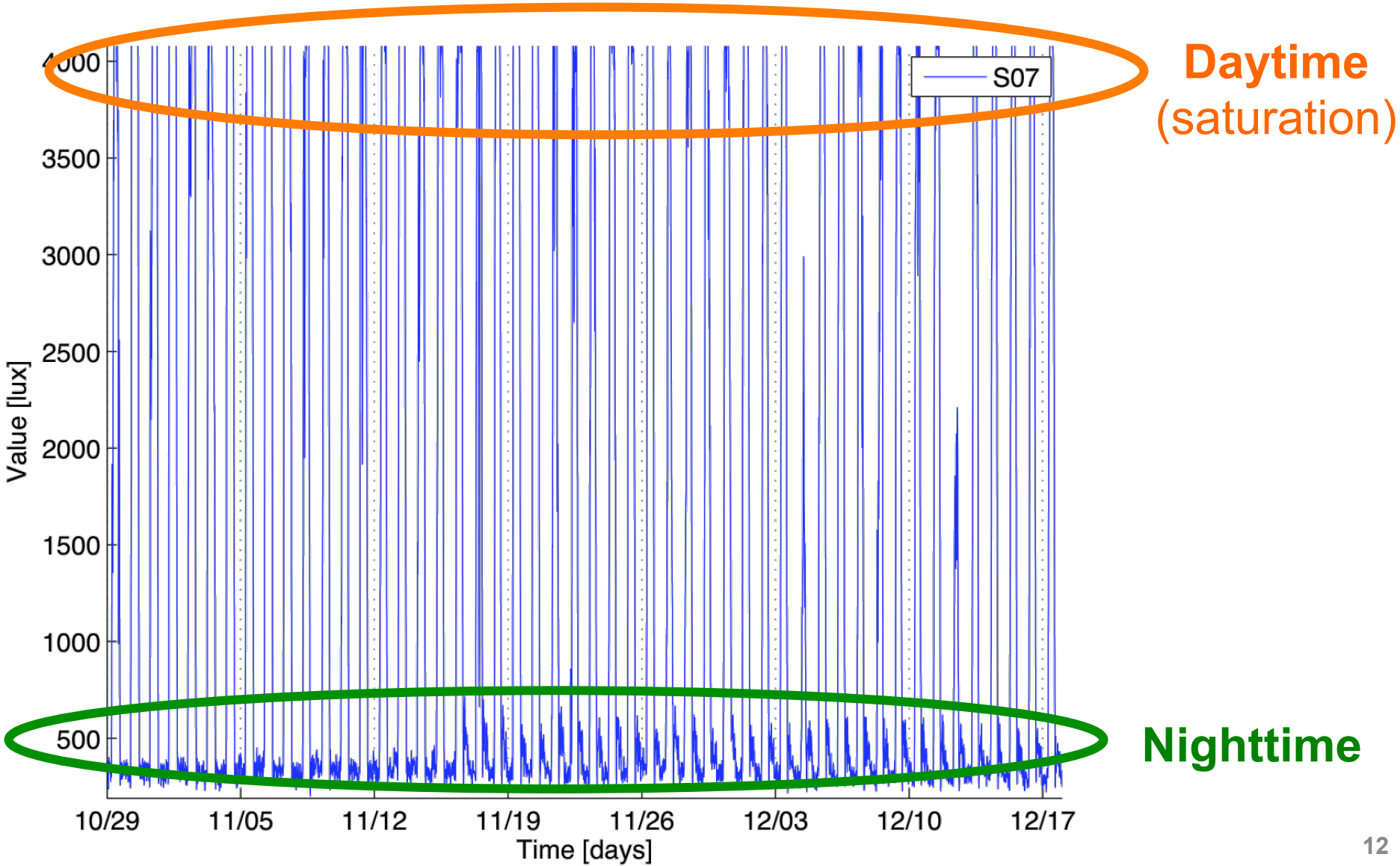
Nodes' location on the map



Data collection and reporting

- Each node reads sensors data every 5 minutes
- The average of three readings is stored in a buffer
  - 1 average value every 15 minutes
- A packet can carry 7 (averaged) values for each of the four sensors
  - One full packet transmitted every 7x15=105 min to the gateway

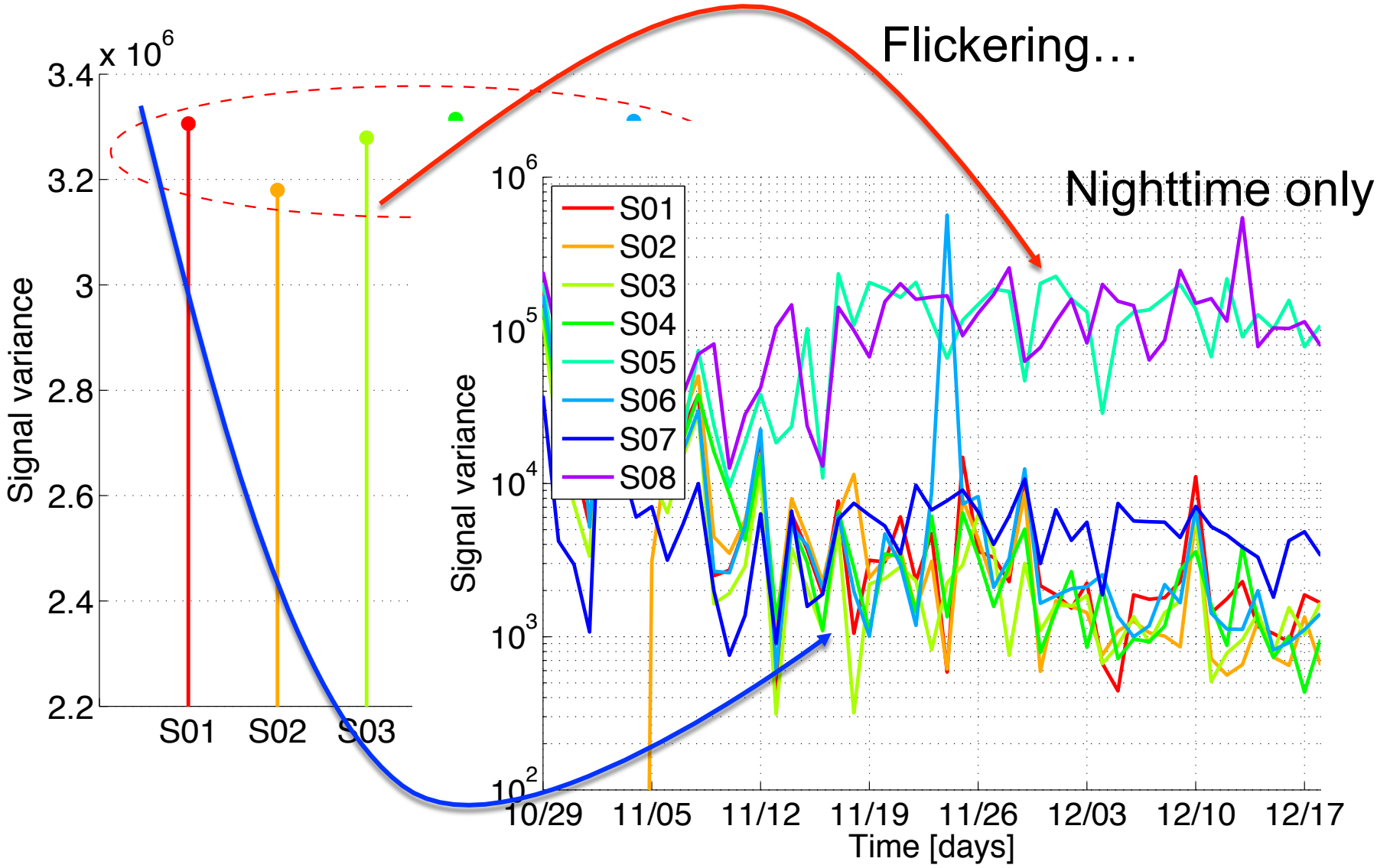
Example of light readings



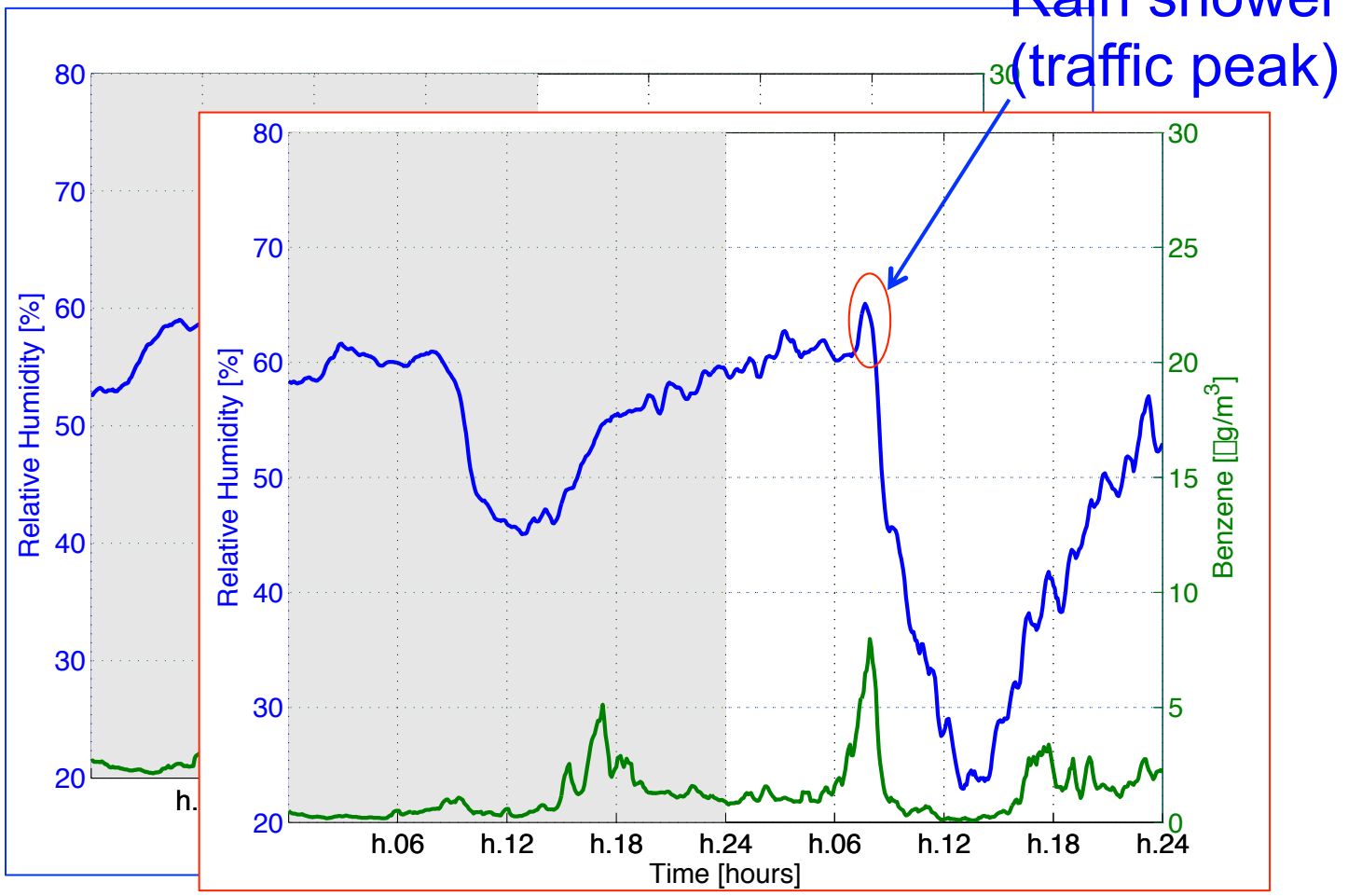
Daytime
(saturation)

Nighttime

Variance analysis



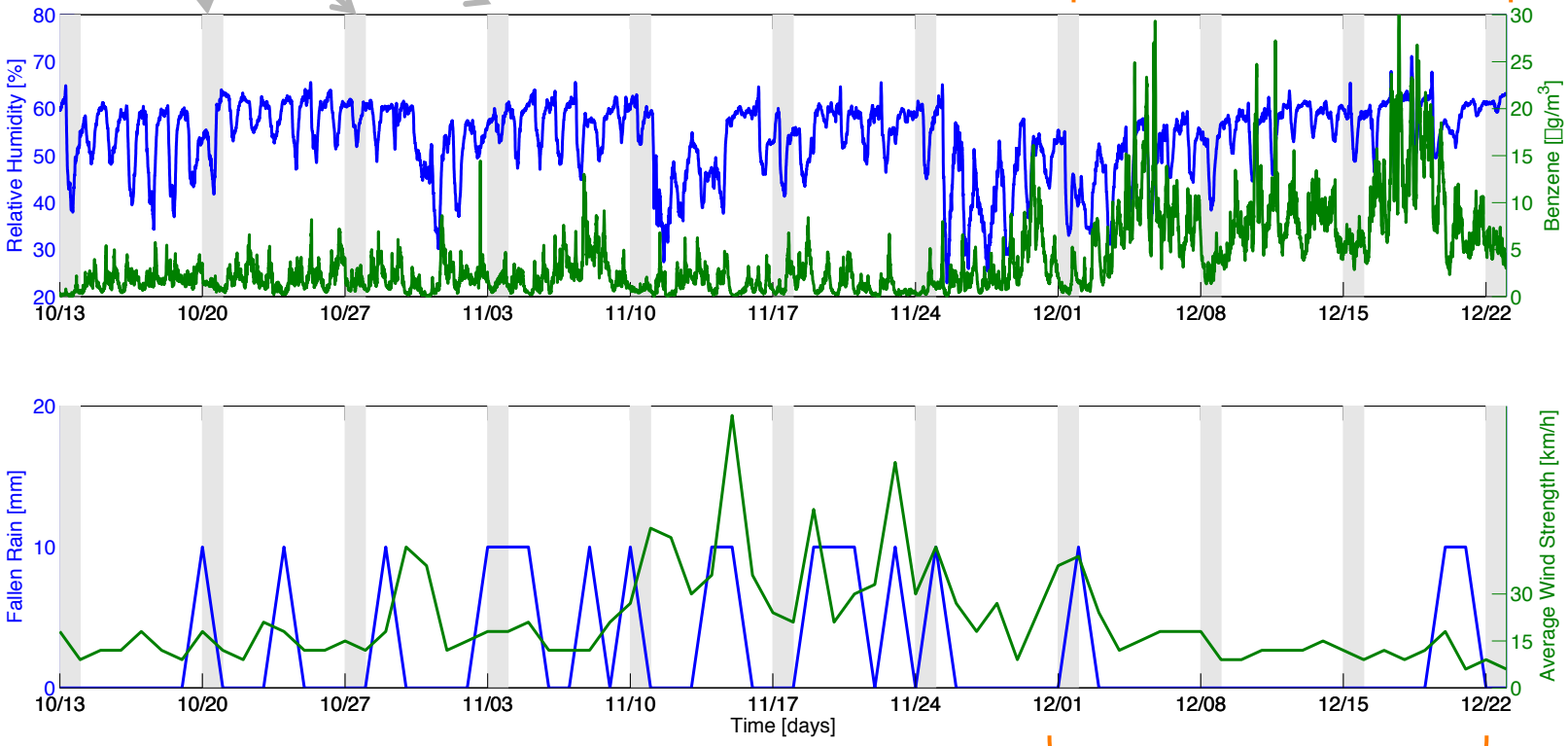
Pollution and weekdays…



Benzene analysis

Sundays

More pollution….



Nice weather….

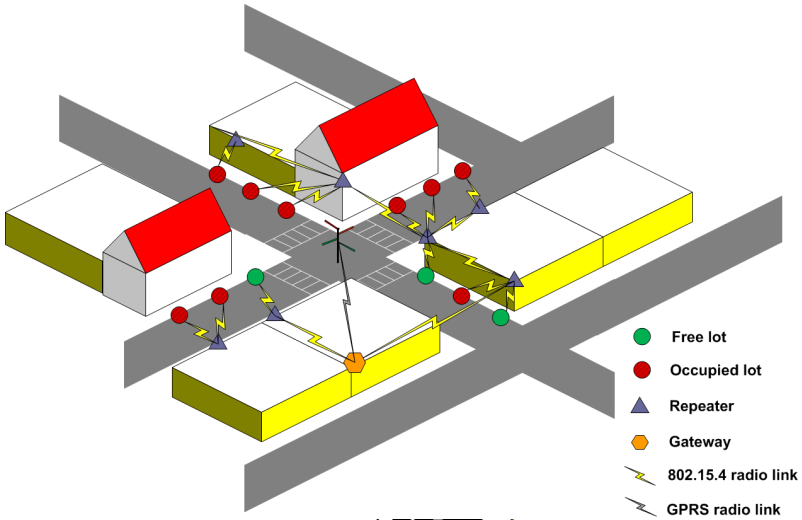
Conclusions

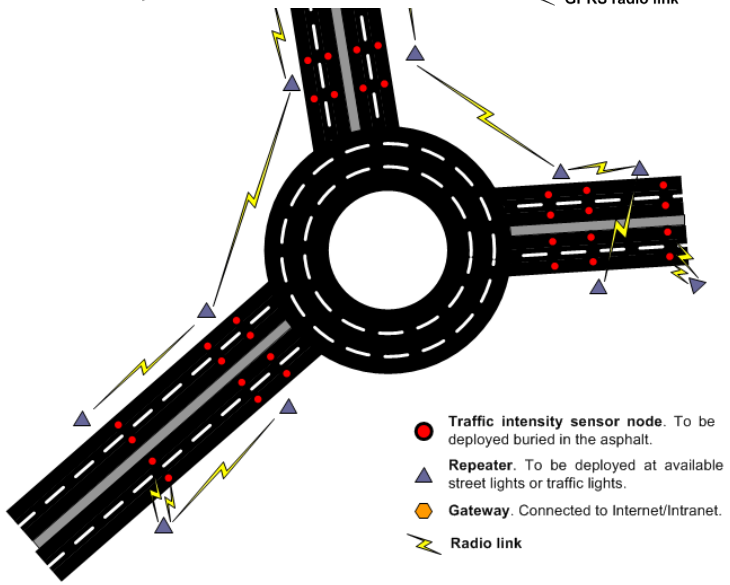
- **Padova Smart City**: a pilot implementation of urban IoT within a Smart City framework
  - Based on web-service, with CoAP+6LowPAN
- **Some results from simple data processing**
  - Humidity, light intensity, temperature, benzene level, weather conditions
- **Next steps**
  - Space/time tagging of data (GIS database)
  - Include other types of data
    - traffic intensity, parking occupancy, city events
  - apply more sophisticated data analysis techniques
  - Get some more funding… ☺
    - Many thanks to HIT (Human Inspired Technology) @ Univ. Padova

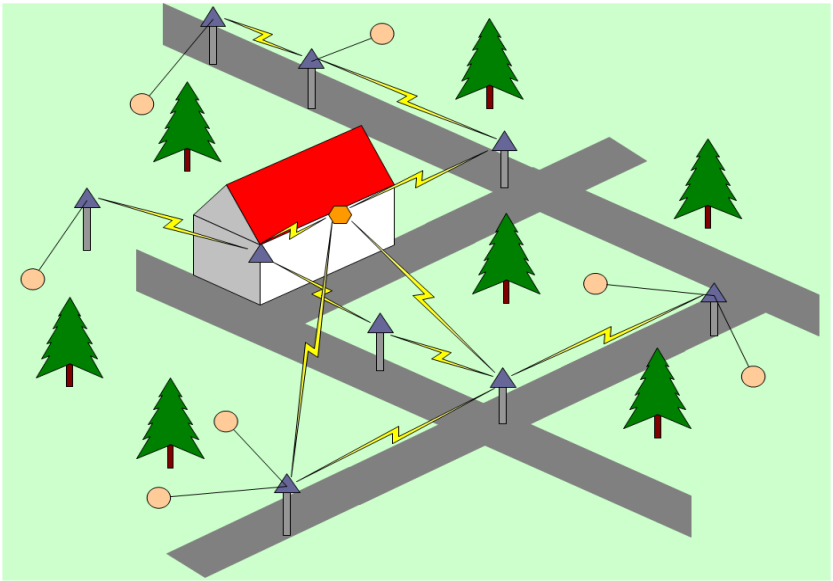
Andrea Zanella

SMART SANTANDER

SmartSantander







Park irrigation monitoring sensor. To be deployed buried in the ground.

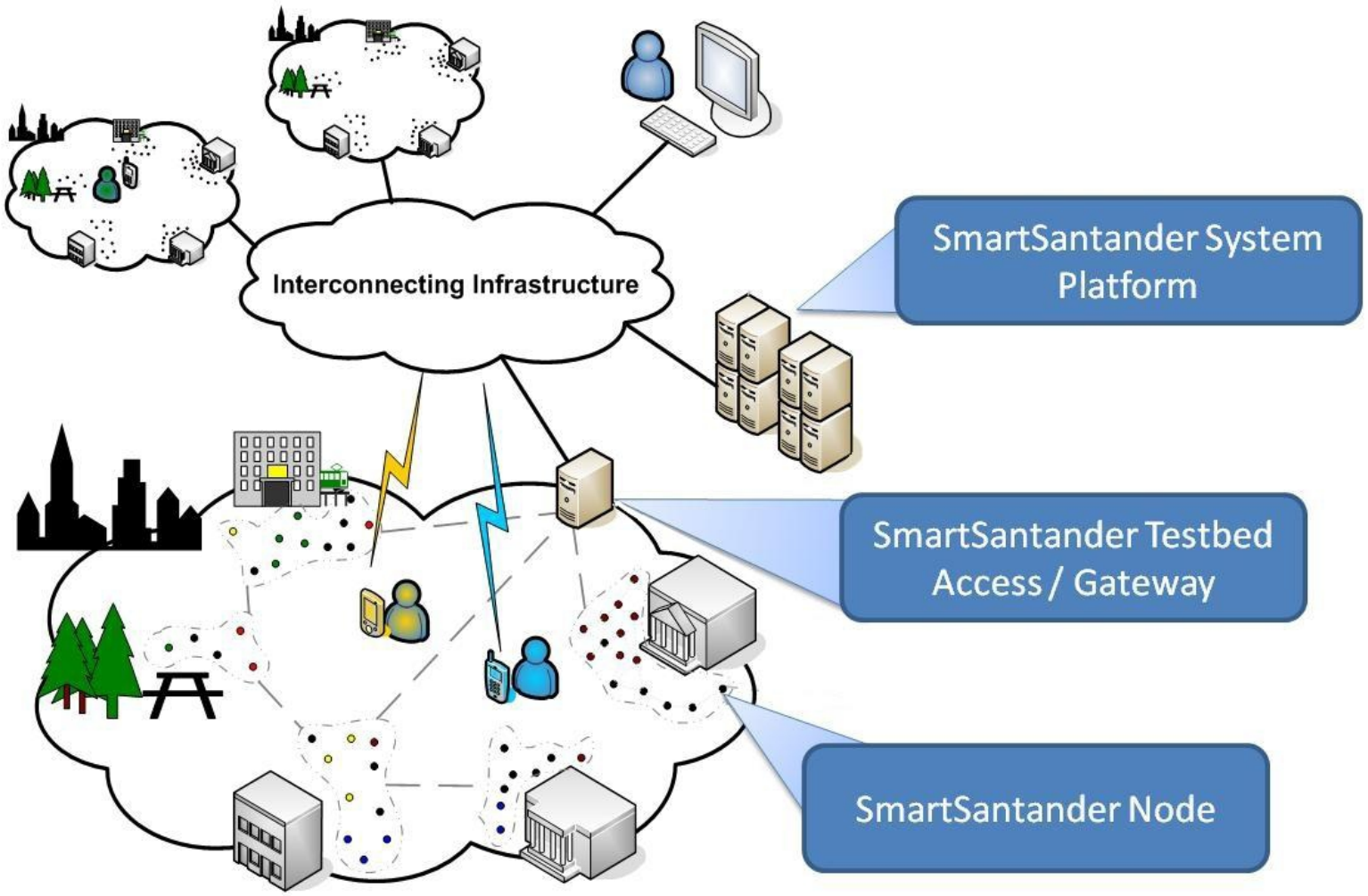
Repeater. To be deployed at available street lights or traffic lights.

Gateway. Connected to Internet/Intranet.

Radio link

Wired link

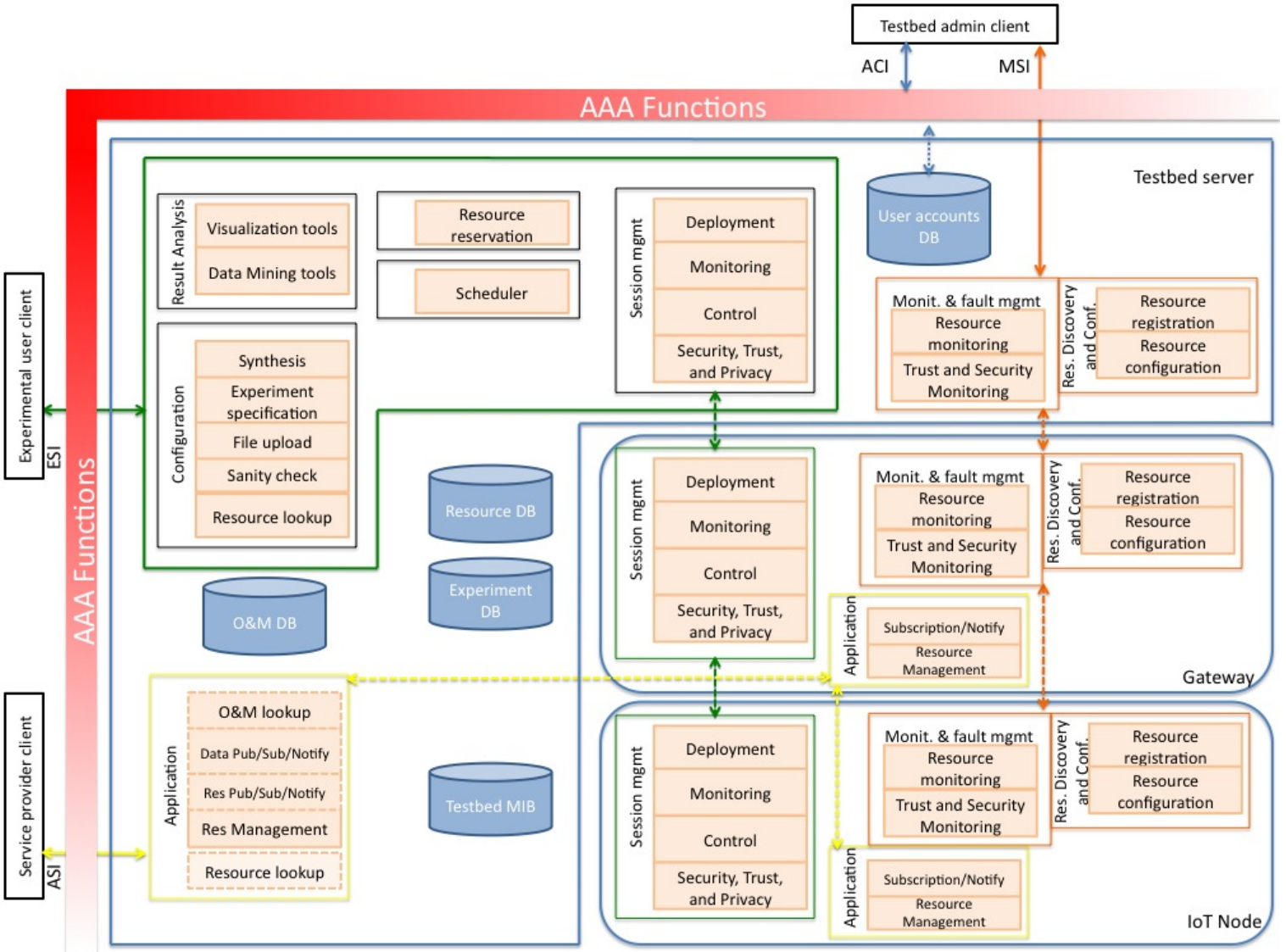
SmartSantander



SmartSantander

- 3-tiered architecture
  - IoT nodes
  - Repeaters
  - Gateways
- 4 subsystems, which operate across a set of different devices (IoT, Gateway and Testbed server nodes) providing different characteristics and capabilities:
  - Authentication, Authorization and Accounting (AAA) subsystem
  - Testbed management subsystem
  - Experimental support subsystem
  - Application support subsystem

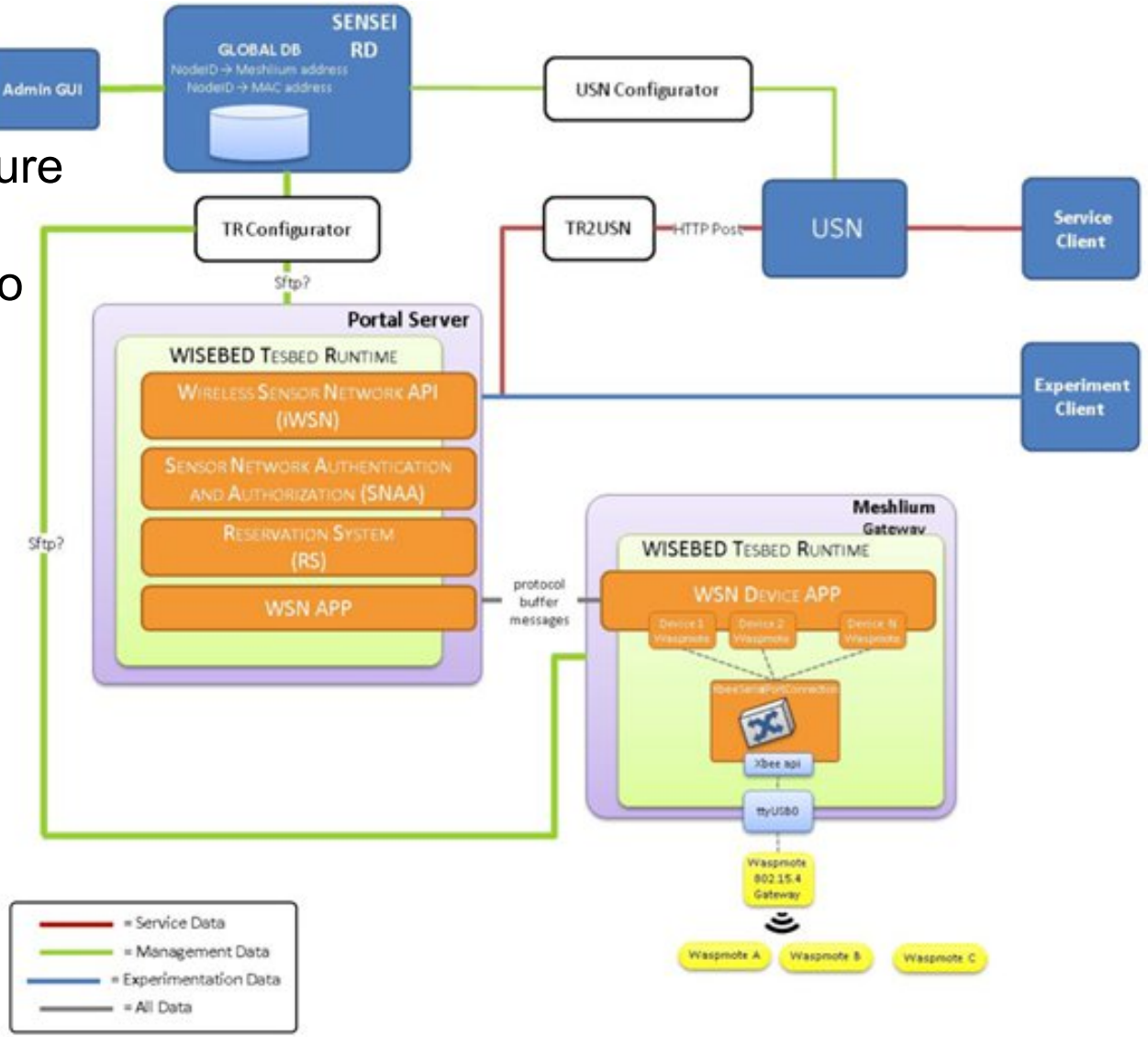
SmartSantander



SmartSantander

SmartSantander architecture

- Portal Server: access to facility
- GW node
- IoT nodes



SmartSantander

SmartSantander

Done!

http://www.overstock.com/Home-Garden/Keep-Calm-and-Drink-Coffee-Unframed-Print/7967447/product.html