DIPARTIMENTO
DI INGEGNERIA
DELL'INFORMAZIONE

800 ANNI 1222·2022

UNIVERSITÀ
DEGLI STUDI
DI PADOVA

SIGNET
signet.dei.unipd.it

Introduction: application scenarios

ICT for Industrial Applications
(ICT4IA)

Andrea Zanella (zanella@dei.unipd.it)
Office number: (049 827)7770

SIGNALS AND NETWORKING RESEARCH GROUP

Your perspective…

- Which application scenarios can you imagine?

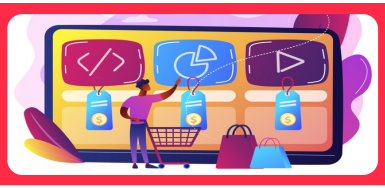
A plethora of possibilities

Industry 4.0 & Industrial IoT

Smart City & Smart agriculture

Smart Building e Smart home

E-Health



Digital Services

Industry 4.0 & Industrial IoT

Process **monitoring**

- **Hugo Boss** uses RFID tags embedded in the carts used to transport semi-finished and finished products, and readers scattered throughout the production site to track the entire manufacturing process, allowing supply chain managers to monitor and control the process at the highest level
- The middleware is designed so that a **light signal** will activate and confirm to operators that the reading has been taken

https://group.hugoboss.com/en/newsroom/stories/smart-factory-in-izmir

Process **control**

- **Harley-Davidson** has installed IoT sensors and software at its York (Pennsylvania) plant that records the performance of various pieces of equipment
  - for example, the speed of the fans in the spray booth
- Software can automatically adjust the machine if it detects that a measurement has deviated from acceptable ranges
- **GM** uses environmental sensors to decide if it's too wet to paint a car
- If the system finds that conditions are unfavorable, the car is routed to another area of the production process
  - Re-painting is reduced and plant downtime is reduced
- This change alone **saved the company millions of dollars**....

Energy management

- IoT and automation of environmental controls such as Heating Ventilation Air Conditioning (HVAC) and electricity can create cost savings for manufacturers
- Integrated energy control systems can enable peak demand prevention and promote more economical energy consumption patterns
- GE says a 5% efficiency improvement in a small industrial power plant generating 15MW can save an average of more than $200,000 per year

Smart Retail

- IoT can help **brands protection** through smart labels
  - enable the identification of every single item throughout the supply chain
  - make products "talking”

- For example, a branded shoe can contain an Rftag with a unique code that customers can read with their device's NFC and verify the originality of the product with an App developed by the manufacturer

<Name Surname> <e@ma.il>

Dynamic production

- Conagra Mills produces 800 different types of flour for its customers
- Uses predictive tools and services to forecast pricing, capacity needs and customer demand
- This has allowed the company to maximize revenues through improved margin decisions and increase capacity utilization by 5%.

<Name Surname> <e@ma.il>

How to leverage ICT

- Improving process **efficiency**
- **Innovation** and creation of products/services
- **Customization** of products/services
- Direct **data monetization**

Improving process **efficiency**

- Monitoring of production processes → enable better efficiency
  - reduction of production time/costs
  - Reduced downtime for maintenance
  - Improve customer service
- For example
  - Supermarkets and stores can use position sensors to identify the products of most interest to customers and sales data to decide on more effective commercial strategies
  - Acoustic sensors can produce a sound map of an industrial environment and detect anomalies caused by machinery malfunctioning
  - RFtags can be used to track the duration of an object's production phases and help identify bottlenecks

Innovation

- Data can enable improving existing products/services or generating new ones
- For example
  - A utility can offer better customer service by making certain metrics visible (e.g., gas savings with hybrid boilers) and offering rapid assistance by interacting remotely with the machines
  - Digital twins + VR + AR can be used to provide remote assistance to certain machineries, cutting down time and cost of maintenance and actually opening up a new business opportunity (remote assitance gold service does have a cost…)

Customization of products/services

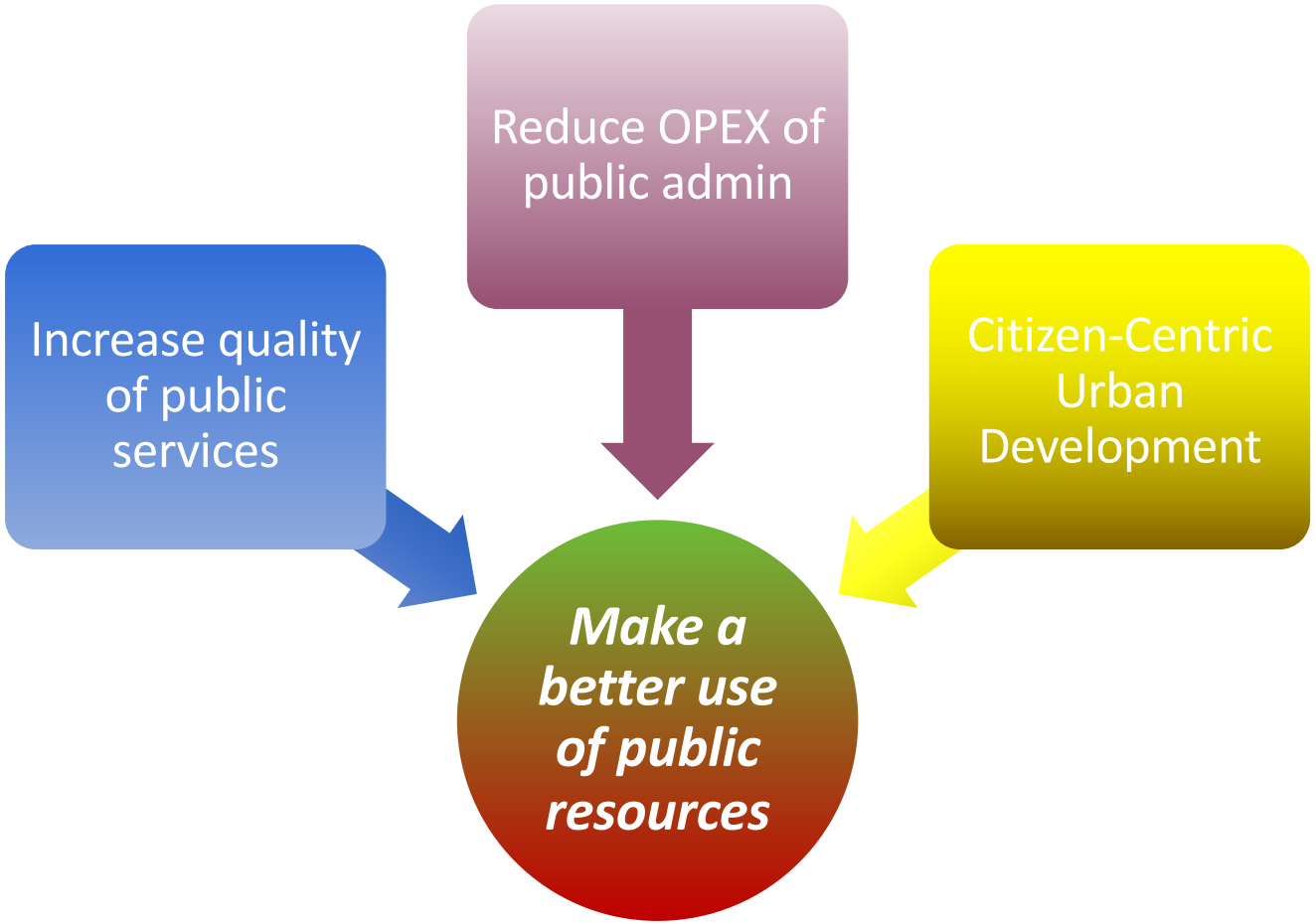
- Services can be personalized based on customer's preferences, increasing the perceived value
- For example
  - A delivery company can propose dynamic rates depending on the time and place of delivery chosen by the customer
  - A utility can leverage Smart Metering data from homes to provide recommendations on how to reduce waste based on specific user habits
  - An app development company can propose personalized running routes based on weather, traffic, and biometric data
  - A clothing store can suggest specific sports equipment based on a customer's physical and motor characteristics

Monetizing

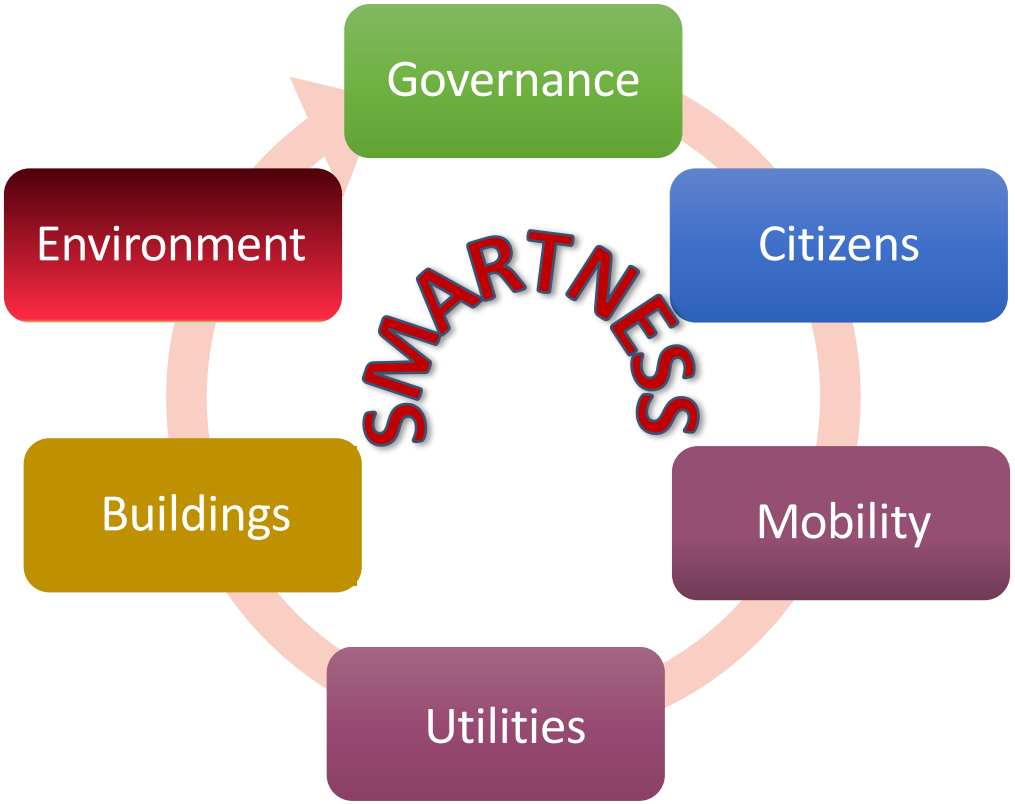
- Data (in particular, personal data) may be transferred to third parties, generating a profit
- For example
  - Data on traffic conditions collected by Smart Cars may be sold to web-based traffic service providers
  - Home air quality data may be of interest to companies that sell air purifiers
- Personal (not anonymous) data may have very high value in the market… but, of course, there are some ethical/privacy issue to consider
  - **'if you're not paying for the product, you are the product'**

Smart City & Smart agriculture

Smart Cities concept



The 6 pillars of city smartness

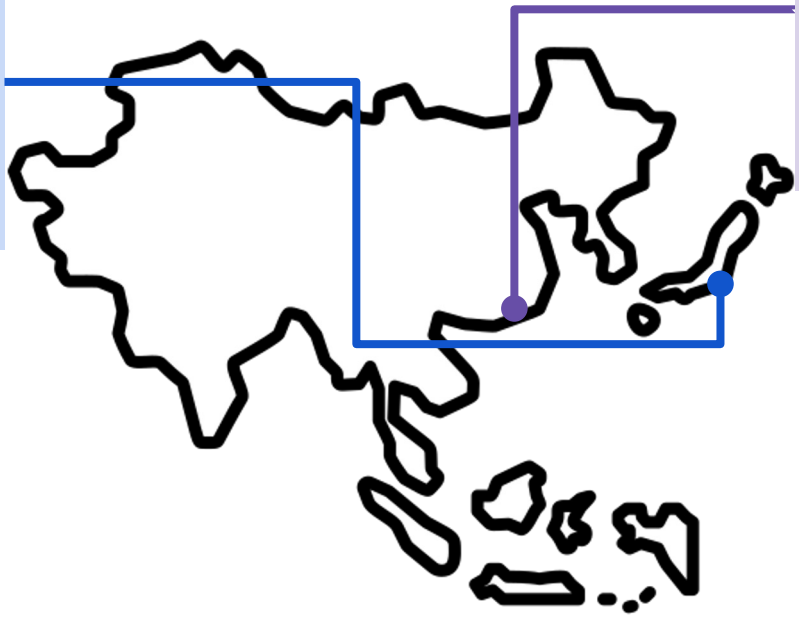


Smart City Services

Examples from the globe

Fujiwasa, Japan

The Fujisawa Sustainable Smart Town (SST) deals with **energy conservation**, with additional focus on community, mobility, security, and healthcare. IoT sensors, controls, and networking support this initiative.



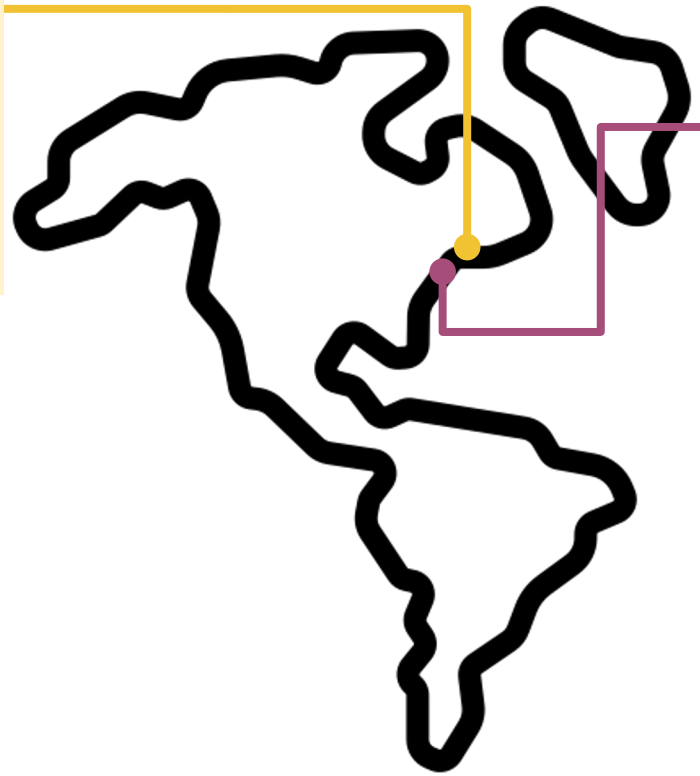
Hong Kong;

City I&T Grand Challenge
Smart lamppost pilot scheme (led lighting, Wifi+5G, traffic monitoring, positioning service, environmental monitoring)

Icons available at www.flaticon.com

Boston, MA

The BOS:311 **mobile application** allows residents to instantly report city issues (e.g., potholes, blocked drains, and faulty street lights). As soon as a report has been submitted, the app forwards the report automatically into the city's work order system.



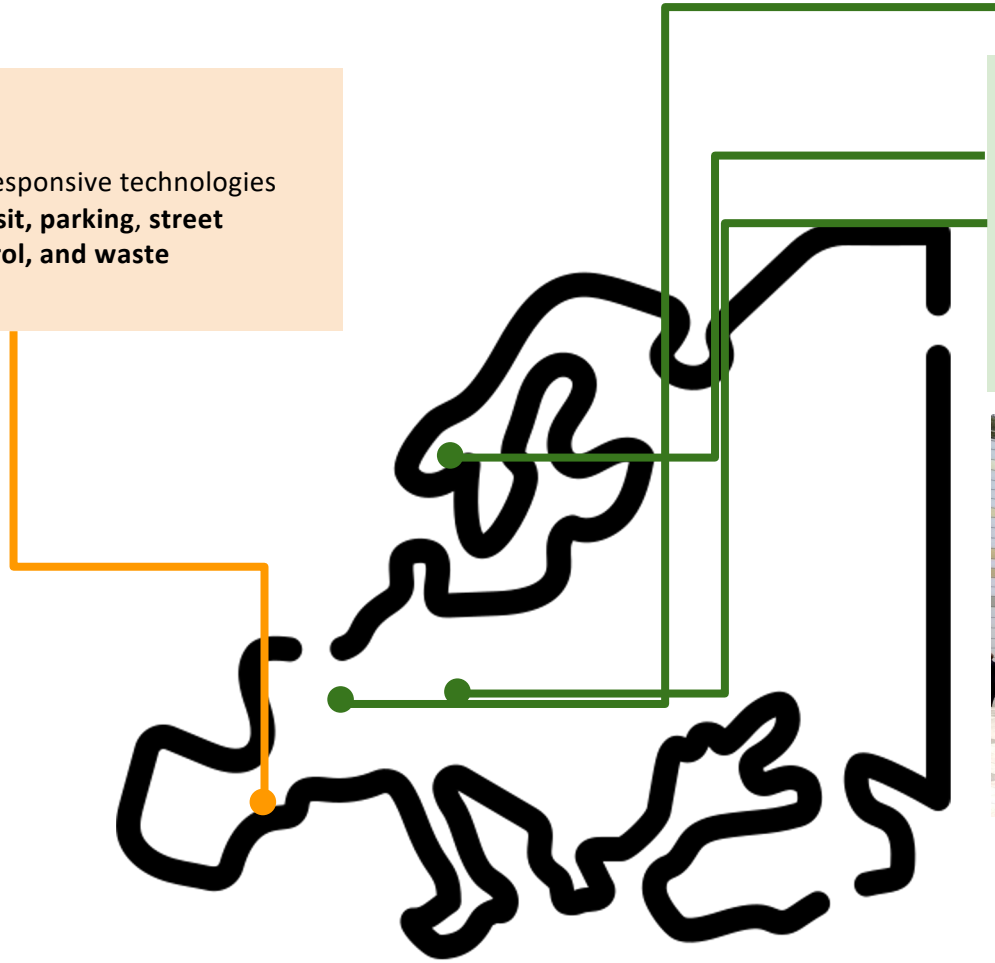
New York City, NY

ShotSpotter is a gun fire detection system. The sensors working collaboratively can detect the geolocation of weapons fired. The data collected by the sensors can also be used to assess trends and crime hot spots in urban areas

Icons available at www.flaticon.com

Barcelona, Spain

The city has deployed responsive technologies that include **public transit, parking**, **street lighting**, **pollution control, and waste management**.



Oslo, Norway; Dresden and Klingenthal, Germany; Paris, France; London UK, …

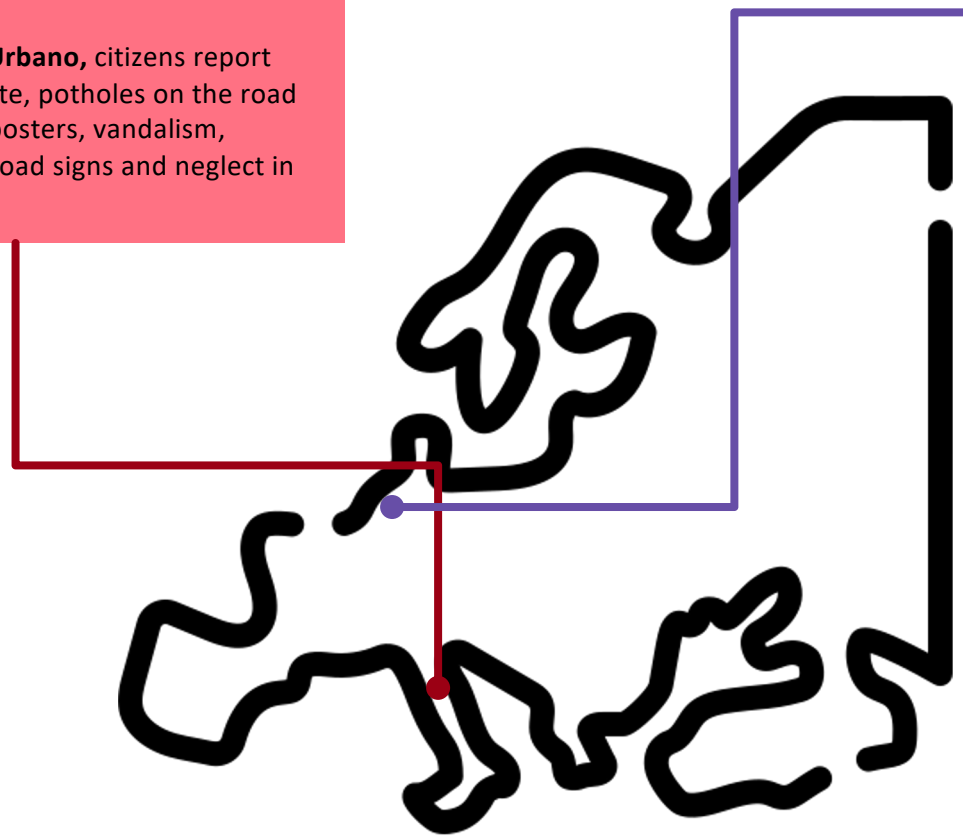
Green City Solutions' **City Tree** combines plant life and IoT technology to improve air quality in tight urban spaces. The City Tree is a bioengineered vertical 12ft stand that is able to purify the air around it with a capacity equivalent to 275 trees

Icons available at www.flaticon.com

Image available at: https://content.assets.pressassociation.io/2018/03/22093802/e1cb2927-e87b-42a5-94e9-9d2e0403fd7b-1366x768.jpg

Italy

WeDo Decoro Urbano, citizens report abandoned waste, potholes on the road surface, illegal posters, vandalism, problems with road signs and neglect in green areas



Amsterdam (NL)

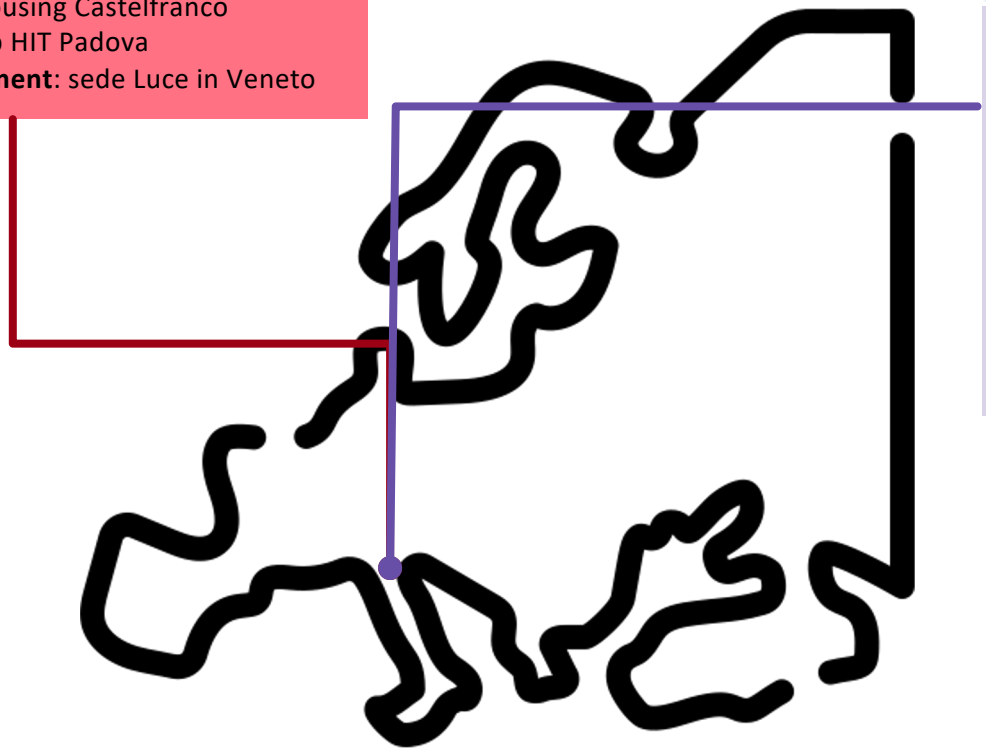
Amsterdam Smart City Challenge
Mobypark app: owners of parking spaces rent them out to people for fee.
Data generated from this app can then be used by the City to determine parking demand and traffic flows in Amsterdam

DOMHO

Italy – Regione Veneto

IoT for human-centric living environments
- **Residential**: co-Housing Castelfranco
- **Nursing home**: lab HIT Padova
- **Business environment**: sede Luce in Veneto

https://domho.it



Safe Place

Italy – Regione Veneto

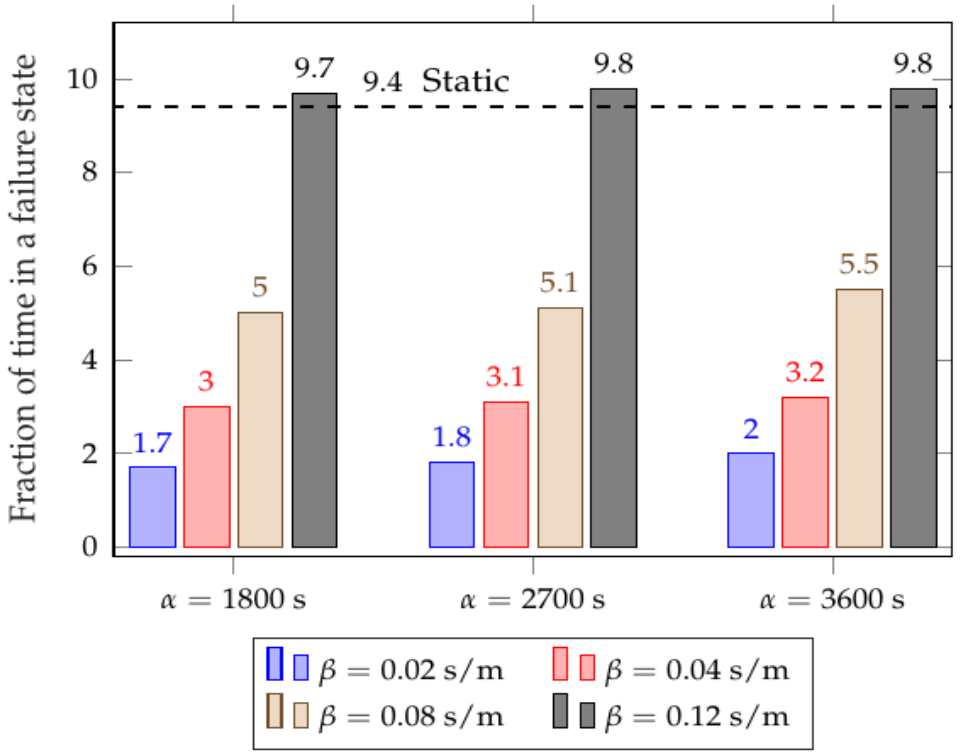
IoT Systems for Healthy and Safe Living Environments

Safe Space&Objects: bakery in Mestre (VE)
Safe Path: library in Piazzola sul Brenta (PD)
Safe Air: rehab gym at UNIPD
Safe Talk: PoC of application
Safe Place: classroom in La Fenice (PD)

https://www.safe-place.it/progetto/

POR 2014/2020
FESR / REGIONE DEL VENETO
UNIONE EUROPEA
REGIONE DEL VENETO
Un moltiplicatore di opportunità.
Da non lasciarsi sfuggire.

Smart Bike


Fraction of time in a failure state
0
2
4
6
8
10
9.7
9.4 Static
9.8
9.8
1.7
3
5
1.8
3.1
5.1
2
3.2
5.5
α = 1800 s
α = 2700 s
α = 3600 s
β = 0.02 s/m
β = 0.04 s/m
β = 0.08 s/m
β = 0.12 s/m

Roadblocks & Challenges

Smart City

- **From IoT Observatory 2018***
  - **36%** of Italian municipalities have started at least one Smart City project from 2016 to 2018*.
  - **80%** of the projects **stop at the experimentation phase**
  - The projects launched are more robust, innovative and structured

- **From Smart City Observatory 2023+**
  - Smart City market: 900 millions of euro **(+ 23%, compared to 2021**)
    - Public lighting (24%), smart mobility (21%), smart metering & smart building (12%)
  - 39% of municipalities have started at least one Smart City project in 2022
  - **89%** want to **continue investing in new initiatives** for the Smart City
  - 41% of municipalities say they intend to invest in Smart City initiatives in the next three years

**Osservatorio Internet of Things della School of Management del Politecnico di Milano, presentata al convegno "Buon compleanno Internet (of Things)".*
+ Osservatorio Smart City: "Smart City: andare oltre la "Terra di Mezzo", 2023

Roadblocks

Financial aspects

Lack of money for investments with long-term returns

Lack of clear business model

Political issues

Decision-making responsibility

Data ownership

Fragmentation

Technical impairments

Plethora of heterogeneous non-interoperable technologies

Need for skilled workforce

Data Privacy and Security

a lot of private information can leak from (or wormed out of) a sensors, IoT devices, databases → privacy from design is necessary

Smart Building e Smart home

Smart buildings

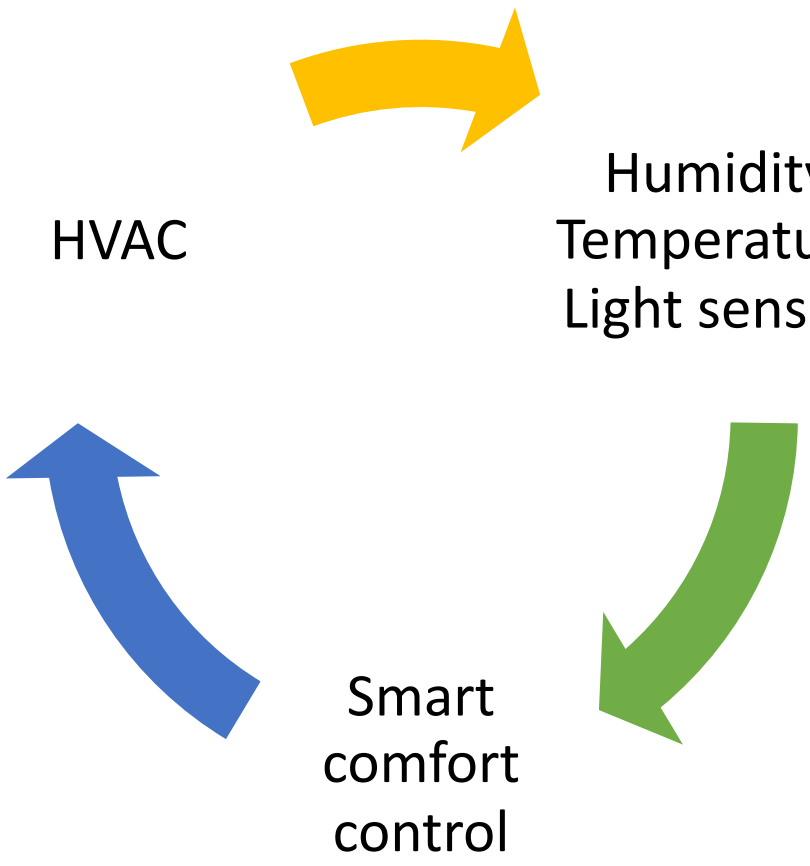
- Monitoring of conditions of (historical) building
  - Polluting levels
  - Humidity/temperature
  - Vibrations
  - Tension sensors in the structure

- Improve energy efficiency
  - Control temperature, humidity, lighting to enhance comfort while reducing costs
- Keep an eye on structural health of the building
  - E.g., schools, historical buildings…

Comfort and healthiness of living environments

- Closed room
  - CO_2 < 600 ppm
  - CO_2 >1000 ppm
  - CO_2 >2500 ppm
- Experimental study: school Coletti Feb/
  - CO_2 level
    - after 30 min → 1950 ppm
    - opening the window for 5 min → 800 ppm
    - outdoor → 600 ppm

Smart living environments



- Same comfort level can be achieved by different combinations of humidy & temperature
- Smart comfort control algorithm finds the configuration that provides the desired comfort level by minimizing the power consumption of Heating Ventilation Air Conditioning (HVAC) system

Wrap up: “smartness” roots

- Digitalization of the processes
  - First thing first, processes need to become digital, in order to simplify sharing, processing, analysis, …
- Interoperability
  - Digitalization can be (almost) useless without interoperability (both horizontal, i.e., between digitalization approaches for the same process, and vertical, i.e., between different processes)
- Sharing
  - Enabling information sharing among processes and systems (IoT paradigm) to disrupt the *silos* approach and enable cross-sector services

Wrap up: “smartness” roots (cont)

- Context awareness
  - Capability to ‘perceive’ the environment, interpret the situation, capture significant variations, …
- Inference
  - Context awareness captures the current state, inference is required to predict the state evolution and plan future actions
- Actioning
  - Context awareness and inference make it possible to act on the system, either manually or automatically, in the most effective way