



Sustainable Networking

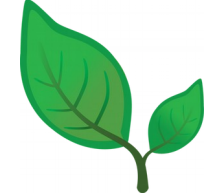
IoT, Edge-Fog-Cloud computing, and ML

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DTIC/UPF 2021



SUSTAINABLE DEVELOPMENT GOALS

17 GOALS TO TRANSFORM OUR WORLD



1 NO POVERTY

2 ZERO HUNGER

3 GOOD HEALTH AND WELL-BEING

4 QUALITY EDUCATION

5 GENDER EQUALITY

6 CLEAN WATER AND SANITATION

7 AFFORDABLE AND CLEAN ENERGY

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

10 REDUCED INEQUALITIES

11 SUSTAINABLE CITIES AND COMMUNITIES

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

13 CLIMATE ACTION

14 LIFE BELOW WATER

15 LIFE ON LAND

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

17 PARTNERSHIPS FOR THE GOALS


SUSTAINABLE DEVELOPMENT GOALS



The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the **17 Sustainable Development Goals (SDGs)**, which are an urgent call for action by all countries - developed and developing - in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that **improve health and education, reduce inequality, and spur economic growth** – all while tackling **climate change and working to preserve our oceans and forests.**



Image and text from <https://sdgs.un.org/goals>



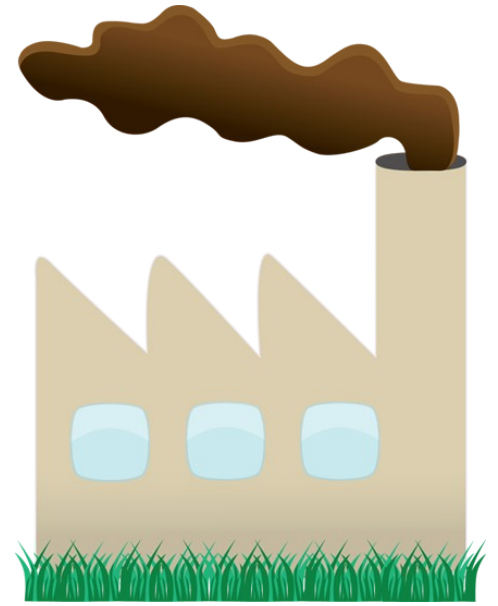
How 'data networks' can help?

- Enablers of technologies to contribute to SDGs.
 - *Internet of Things / Human-centric communications.*
 - *Data-oriented computed architectures*
- Sustainable networking.
 - *Trade-off between energy consumption and performance.*
- Artificial Intelligence / Machine Learning.
 - *Go beyond human capabilities.*

Are you using Internet in a 'green' way?



- *Do you know what is the environmental cost of sending an e-mail, a photo, or a chat message?*
- *Is it efficient listening on-line music? Would not be better to download the songs and reproduce them locally?*
- *Local storage or... in the cloud? Is collaborative document editing efficient?*





Proposed Activity (Lab 2 - MLN)

1) Select 1 SDG you find interesting. Propose a IoT solution to contribute to solve/improve them.

- **Example:** SDG 11 + a sensor network to monitor air pollution in cities + a road traffic control that uses such a data to adjust the max. speed in the streets.

2) For the selected IoT solution, detail which kind of information it generates / receives, and which tasks should be executed to extract information from the gathered data.

- **Example:** air pollution sensors report CO₂, PM_{2.5} particles, etc. every 10 mins as the phenomena measured usually changes slowly.



Proposed Activity

3. Identify which tasks can be performed over the generated data, and where: at the edge of the network (own data only) or in the cloud (big data).

- **Example:** at the edge, we can do predictions regarding future air conditions based on our own data, while in the cloud we can combine our data with others (weather, road traffic, etc.)

4. Propose a ML technique to extract knowledge from the gathered data. Explain and detail your solution, as well as the expected results.

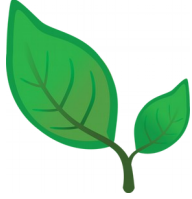
- **Example:** a neural network can be used to predict future critical situations given current air pollution values, amount of road traffic and weather data.



Internet of Things (IoT)

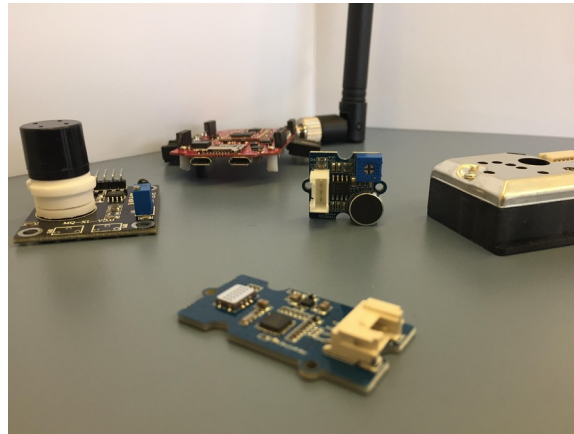
- IoT = Internet of Things → Any 'thing' can generate (sensors) and consume (actuate) data.
- IoT = Tons of data available about... everything (useful or not).

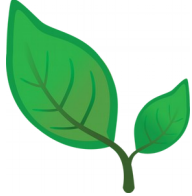




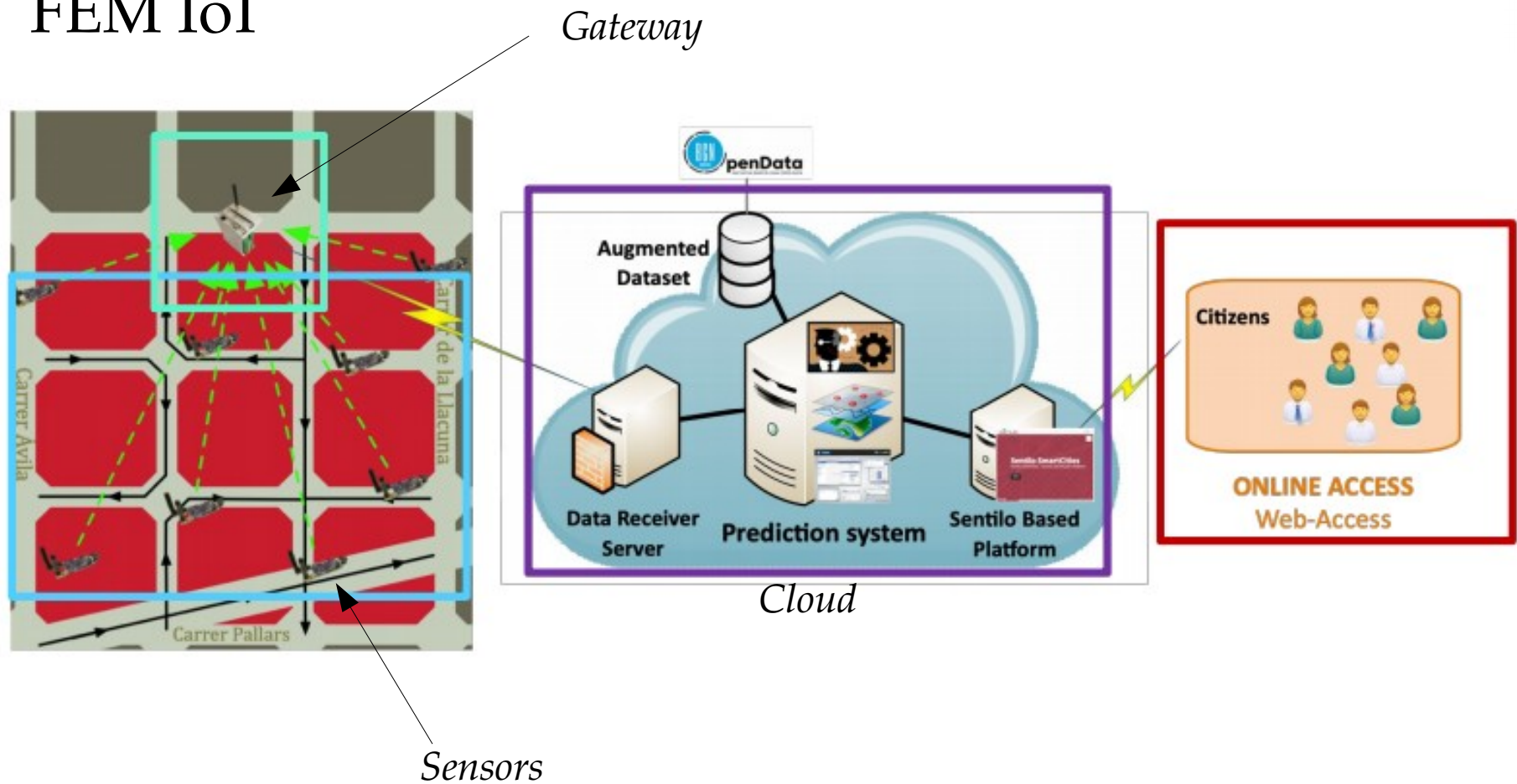
Example: Measuring air and sound pollution in cities

- A IoT project from DTIC /UPF: FEM IoT
- The project FEM IoT Connected Street is moving towards implementation in the city ([link](#))
 - We appear in *L'efecte Papallona, Cat.Radio* ([link](#)) & *Interview in Diari Barcelona* ([link](#))





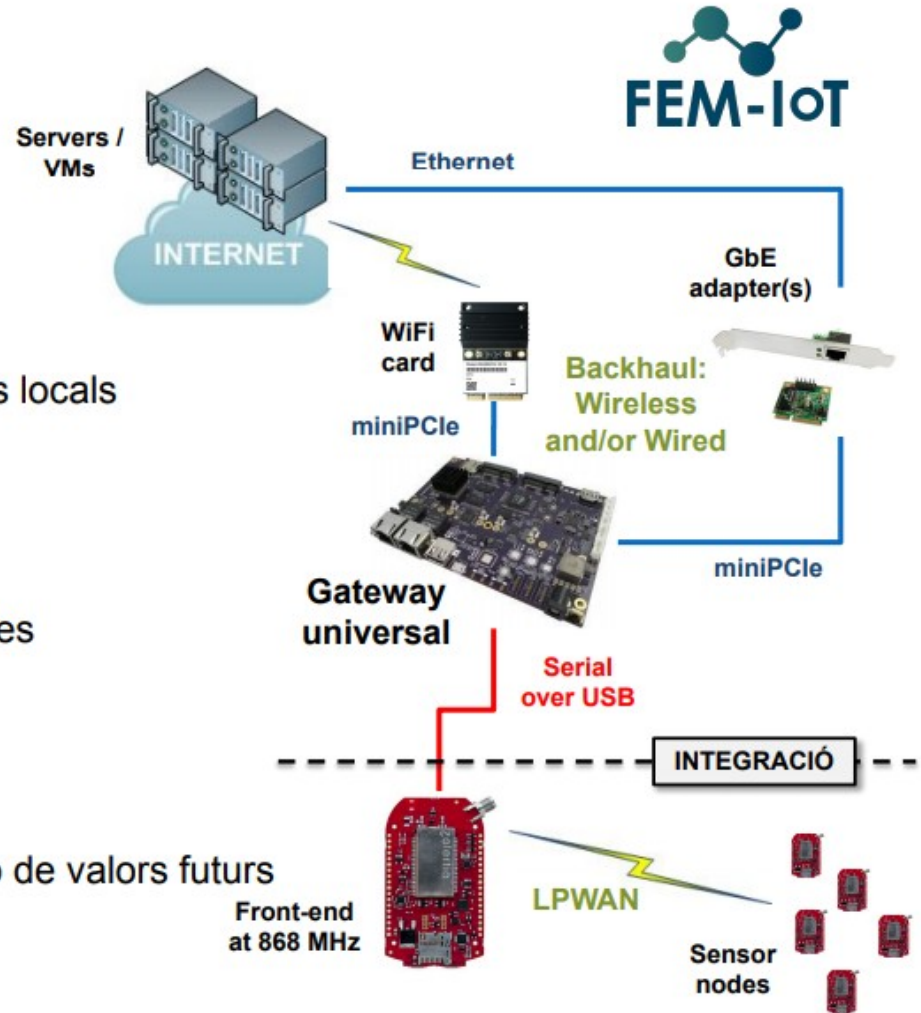
FEM IoT



Mapeig d'elements (II)

Computació Fog/Edge/MEC

- **Edge computing:** Als nodes sensors
 - Filtratge de mesures
 - Detecció d'out of bounds i activació d'alarmes locals
- **Fog computing:** Al Gateway universal
 - Estimació de dades locals a curt termini
 - Configuració dinàmica de la xarxa
 - Detecció d'errors de xarxa i activació d'alarmes
- **Cloud computing:** A servidors / VMs dedicades
 - Processat de dades recollides
 - Integració de bases de dades externes
 - Detecció de patrons, correlacions, i estimació de valors futurs





What about ML in FEM IoT?

- Study the correlation between 'features' of a data set (CO₂, NO, °C, RH, etc.)
- Do predictions about future values
 - based on the own data (pollution, temperature, etc.)
 - Combined with other 'external' data
- And apply them to reduce number of transmissions:
 - Dias, Gabriel Martins, Maddalena Nurchis, and Boris Bellalta. "**Adapting sampling interval of sensor networks using on-line reinforcement learning.**" In 2016 IEEE 3rd World Forum on Internet of Things (WF-IoT), pp. 460-465. IEEE, 2016. [[link](#)]
 - Dias, Gabriel Martins, Boris Bellalta, and Simon Oechsner. "**The impact of dual prediction schemes on the reduction of the number of transmissions in sensor networks.**" Computer Communications 112 (2017): 58-72. [[link](#)]



Air Quality Datasets

- This is not mandatory for this activity, but...
- ... do you want to try? There are some available datasets in the web.
 - Air Quality Data Set
<https://archive.ics.uci.edu/ml/datasets/Air+Quality#>
- For instance, is it possible to create a model able to predict the CO and NO2 concentrations given the temperature, RH and time of the day?

A FEM IoT dataset is available too!

Would you like to do your TFG around these topics?



- Beyond technology, with a clear (although maybe not direct) societal impact, and mapped to UN SDGs.
- Low resource computing devices + sensor technology: software and hardware.
- Computing architectures: virtual machines, servers, edge-fog-cloud computing, data bases, visualization.
- Data analysis, machine learning, generation of models.

