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25 i 26 d'abril
2018

mNACTEC-Terrassa

II Congrés d'Acústica de Catalunya

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Generalitat de Catalunya
Departament de Territori i Sostenibilitat

Diputació Barcelona

Ajuntament de Terrassa

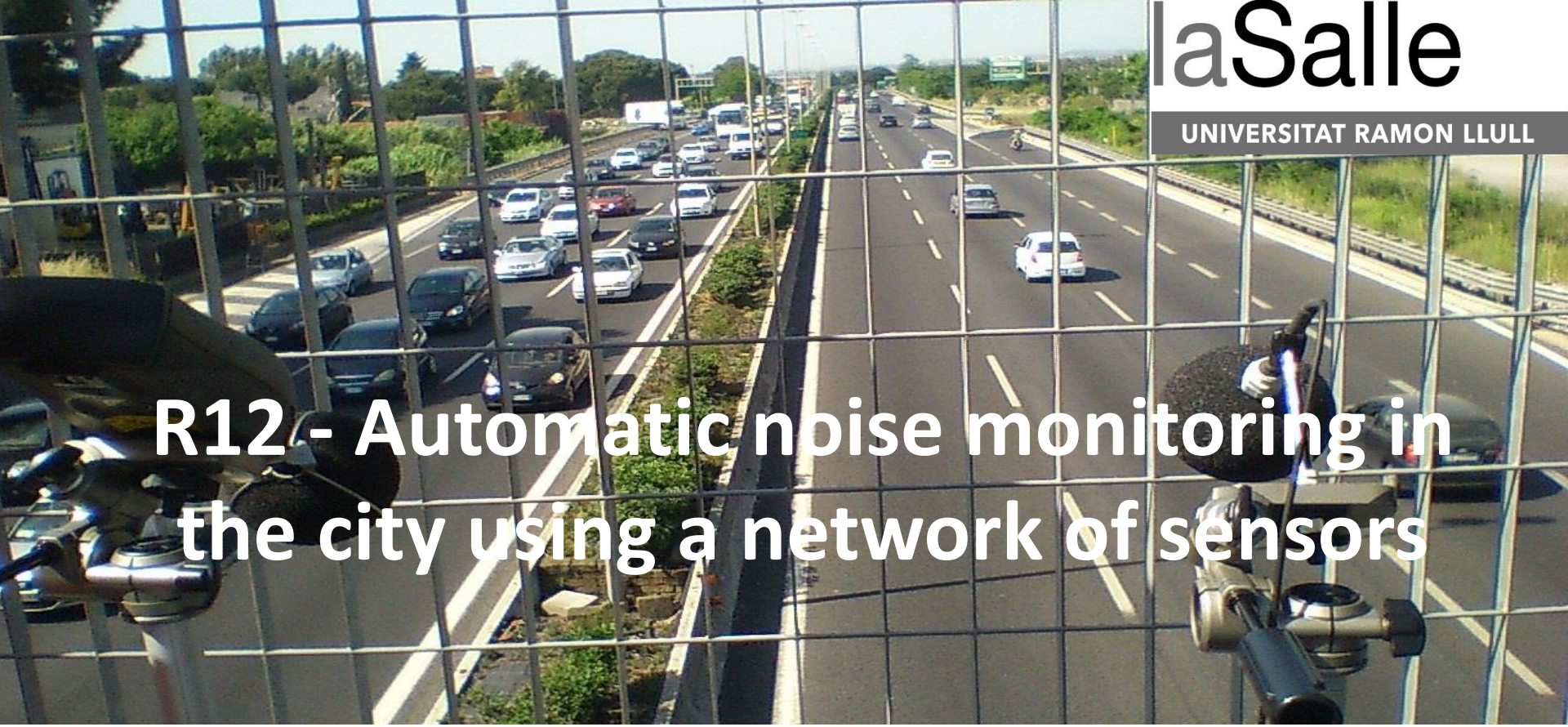
Laboratori d'Enginyeria Acústica i Mecànica
UNIVERSITAT POLITÈCNICA DE CATALUNYA

Associació Catalana de Consultors Acústics

AJUNTAMENT DE SantCugat

Ajuntament de Sabadell

#EUGREENWEEK



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R12 - Automatic noise monitoring in the city using a network of sensors

Moderator: Francesc Alías

falias@salleurl.edu

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Outline

- Introduction of the expert round table
- Brief presentations about key aspects of automatic noise monitoring
- Open debate and discussion between the panelists
- Questions

Outline

- **Introduction of the expert round table**
- Brief presentations about key aspects of automatic noise monitoring
- Open debate and discussion between the panelists
- Questions

Round Table

- **Henk Wolfert**, Chair of FONOMOC at Eurocities.
- **Marc Boher**, COO and Board Member of Urbiotica.
- **Júlia Camps**, Environmental Quality Department of the Barcelona City Council.
- **Dra. Rosa Ma Alsina**, Coordinator of the Signal Processing area at La Salle - Universitat Ramon Llull.

Ajuntament de Barcelona

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- Introduction of the expert round table
- **Brief presentations about key aspects of automatic noise monitoring**
- Open debate and discussion between the panelists
- Questions

FONOMOC objectives

- Henk Wolfert -

- Share experience and knowledge on noise monitoring (traditional and innovative)
- Identify new initiatives and developments in this field
- Currently FONOMOC pays special attention to (low cost) sensors and apps
- Special attention to communication with the citizens, how improve involvement
- Peer review noise monitoring systems,
- Identification and detection of anomalous noise
- Localisation of noise sources causing noise complaints or exceedings of limits values
- To promote noise monitoring and use of open data
- To initiate, identify, support or participate in EU funded projects in this field
- To explore the connection between noise monitoring and possibilities of IoT.

EUROCITIES

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Content

- What is FONOMOC?
- Objectives
- Some examples
- Future

@fonomoc

www.workinggroupnoise.com/fonomoc

What is FONOMOC?

- Focusgroup Of Noise Monitoring Cities

Gdansk
Guests
Blue Wave
Milan
Rotterdam
Tecnalia
Paris
Ghent
Univ. Pol. Madrid
Bruitparif
Turin
Barcelona
Univ. Rome
Resono

FONOMOC

- Exchange knowledge & experiences
- Identification innovations
- Supporting EU funded project
- Peer Review
- Open data

#EUGREENWEEK

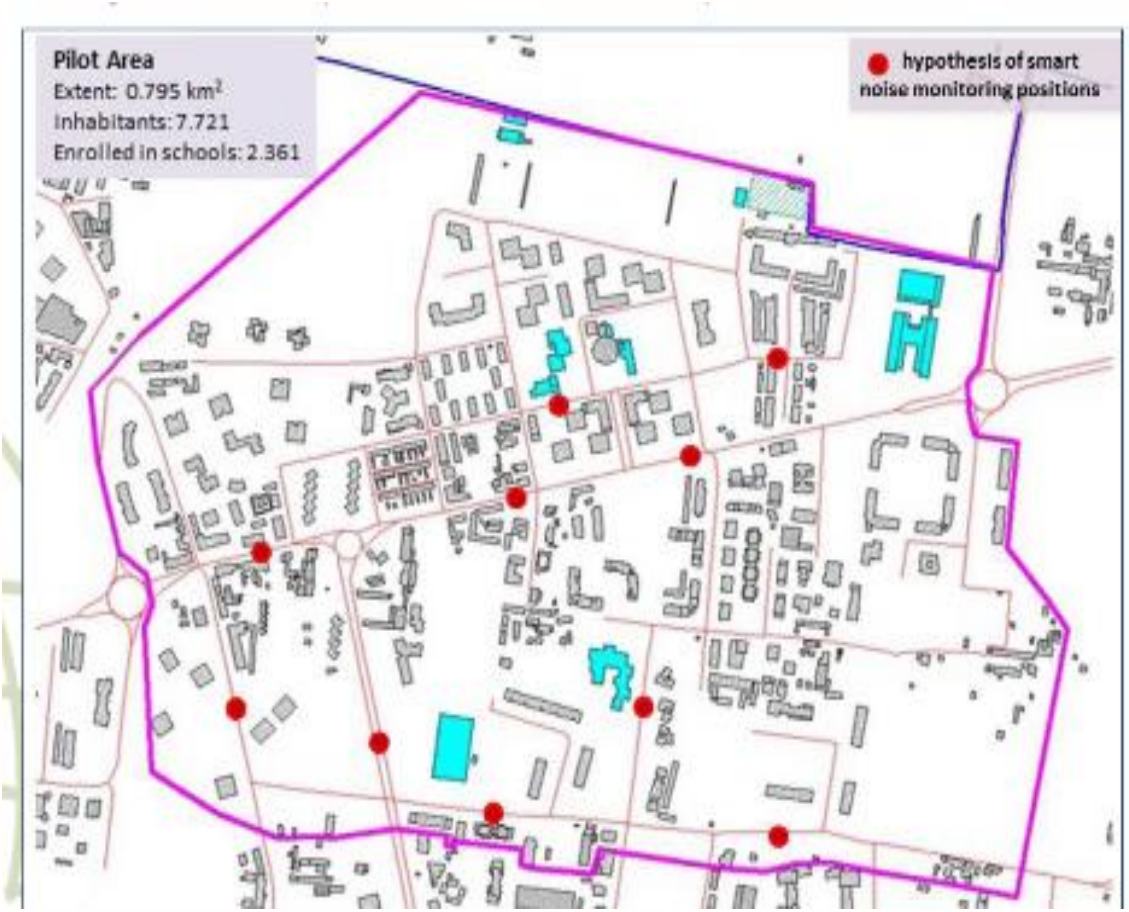
Examples

- City hall square Rotterdam
- Monza
- IDEA
- RUMEUR
- Medusa
- Maasvlakte


MeTrao


SATURN

Monza


Pilot Area
Extent: 0.795 km²
Inhabitants: 7.721
Enrolled in schools: 2.361
hypothesis of smart noise monitoring positions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PM10 (gemiddelde laatste 24u) concentraties op Maandag 02/03/2009 : situatie om 11h00 (lokale tijd)

microgram/m3

0	11	21	31	41	51	71	101	151	201
10	20	30	40	50	70	100	150	200	MAX

■ data beschikbaar
□ data niet beschikbaar

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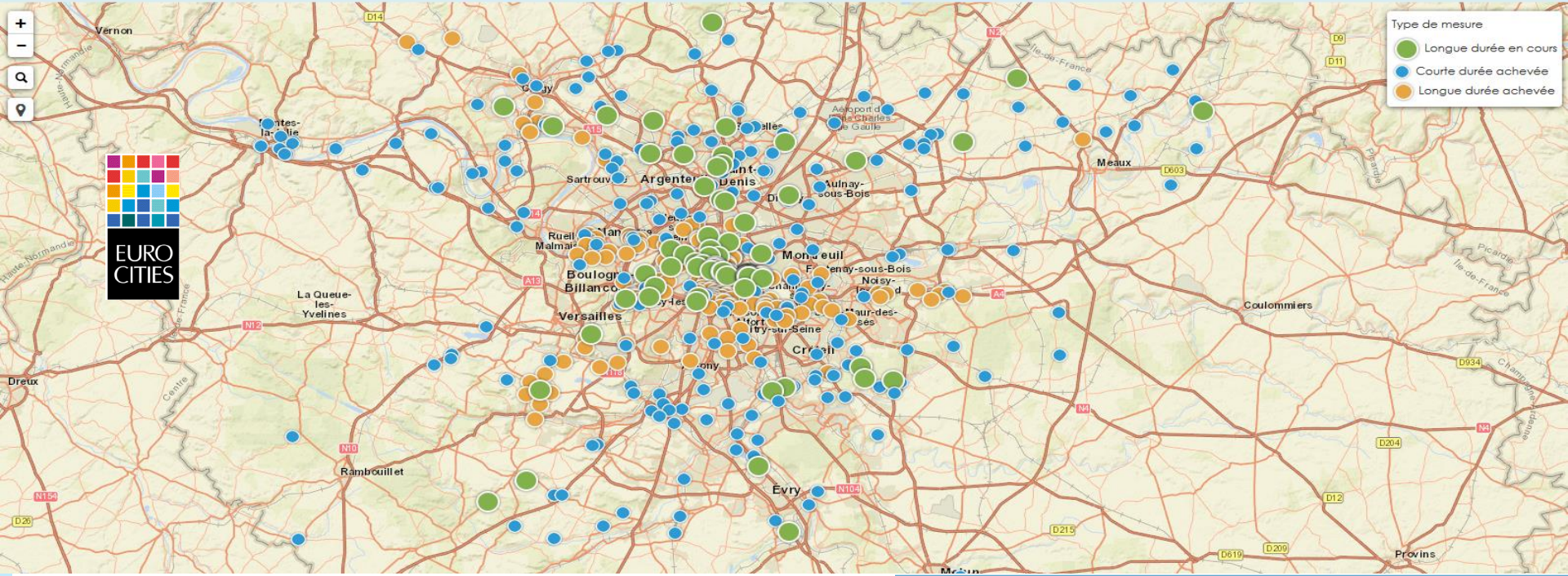

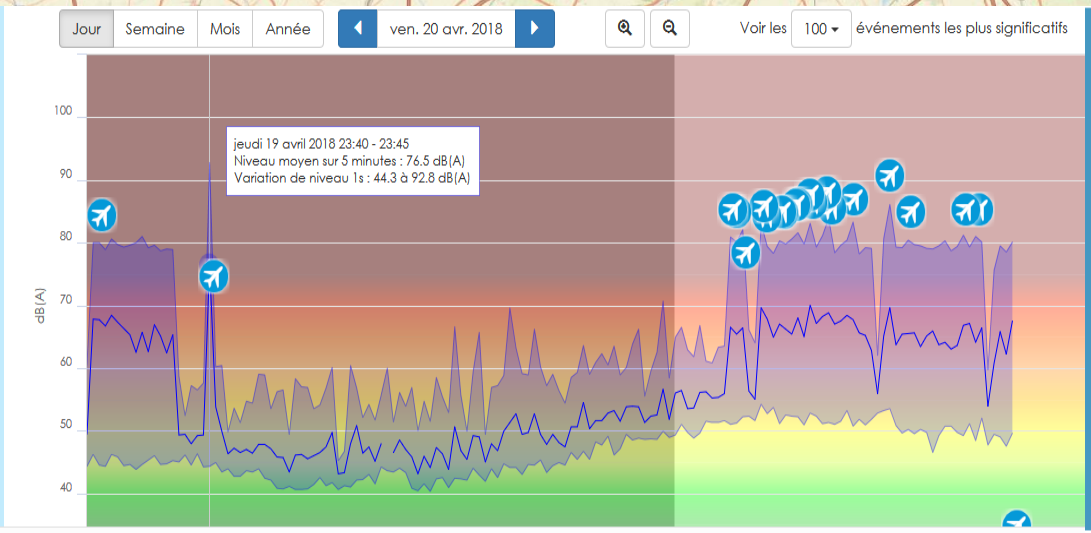

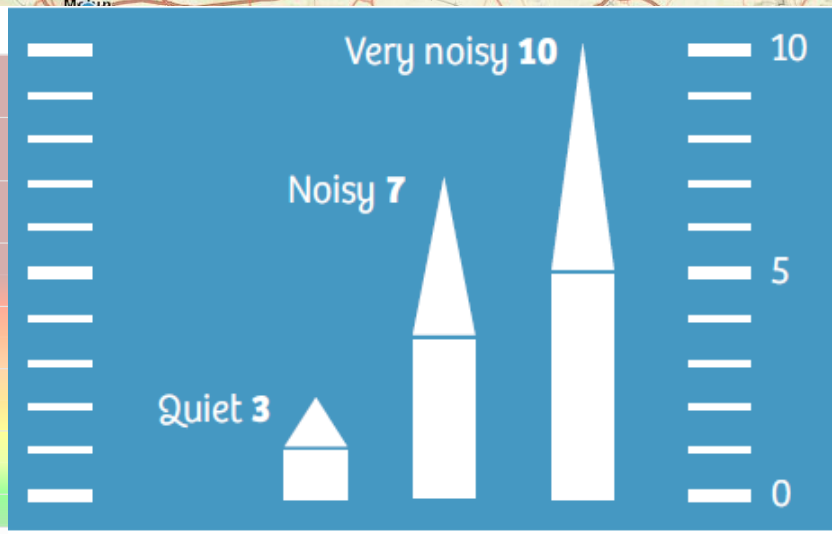

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#EUGREENWEEK

Medusa


Rotterdam, NL
Hoek van Holland, NL
Breeddiep
Antarcticaweg
N15
Maasvlakte
Rotterdam
Noord
Beerkanaal
APM Terminals
Maasvlakte II BV
Coloradoweg
Dardanellenstraat
Dardanellenst
10
9
1
2
3
8

Future

Has already started!!!!

- Smart cities
- Integrated sensors
- Human sensors
- Citizens involvement

thank you for your attention!

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Continuous noise monitoring

- Marc Boher -

- Advantages and limitations.
- Different approaches from Urbiotica's perspective:
  - Static vs. "mobile" monitoring.
  - Open data for citizens vs. data for internal use only.
  - Dedicated vertical noise management platform vs. Smart Cities platform

urbiotica

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Automatic noise monitoring, why?

The challenge to face up by Cities:

Reduce the noise levels in city zones where limits are exceeded **Improve life quality of the citizens**

Do they have the necessary tools against noise pollution?

Normative compliance

+

Sound Meter
Traditional equipment

Studies based on **punctual and manual measurements are expensive equipment**
Evaluation of the situation **highly spaced in time** (5 years)

✓ Normative Compliance	✗ Citizens Demands	✗ Solution to pollution problem

Automatic noise monitoring, why?

Low-cost and permanent **noise control system**
Complementary to traditional monitoring equipment

- **Increase** the number of **measurement points**
- **Quantify** the **results** of the **action plans**
- **Anticipate citizen demands**
- **Detect changes** in noise levels **trends**
- Identify **new sources of noise**
- Make **information available to citizens**

How is it possible?

Irruption of new technologies

Low energy consumption and low cost sensor technologies

Technologies for long-term energy sources

Internet of things

Low energy consumption communication technologies (NBIoT, LORA, Sigfox, etc.)

New Big Data technologies for data processin and analysis

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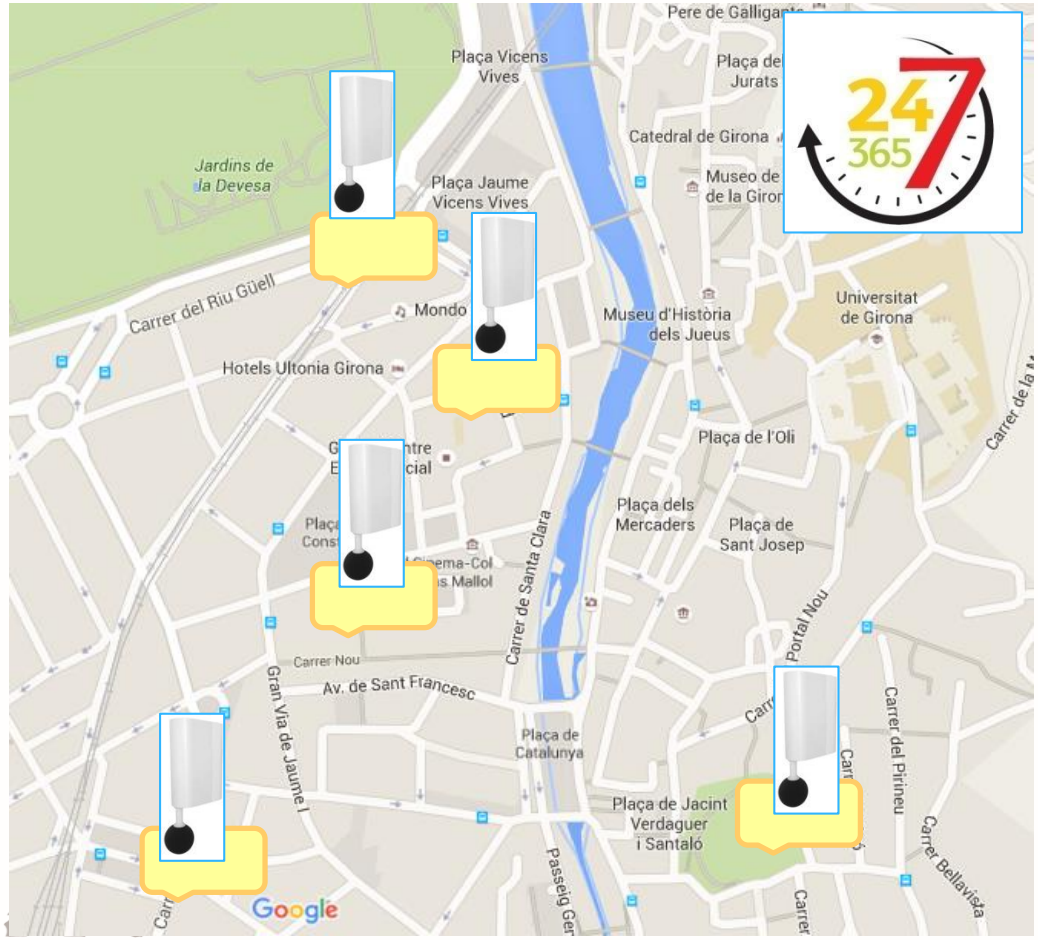
How is it possible?

Noise monitoring network
based on a wireless sensor network



Real time continuous monitoring of the most noisy areas in the city

Web applications for noise pollution management

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Do all cities have the same needs?

- Different approaches on the specific cities challenges:
  - Static vs. “mobile” monitoring.
  - Open data for citizens vs. data for internal use only.
  - Dedicated vertical noise management platform vs. Smart Cities platform

BCN Noise Monitoring Network

Júlia Camps Farrés

Environmental Quality Department

Ajuntament de Barcelona

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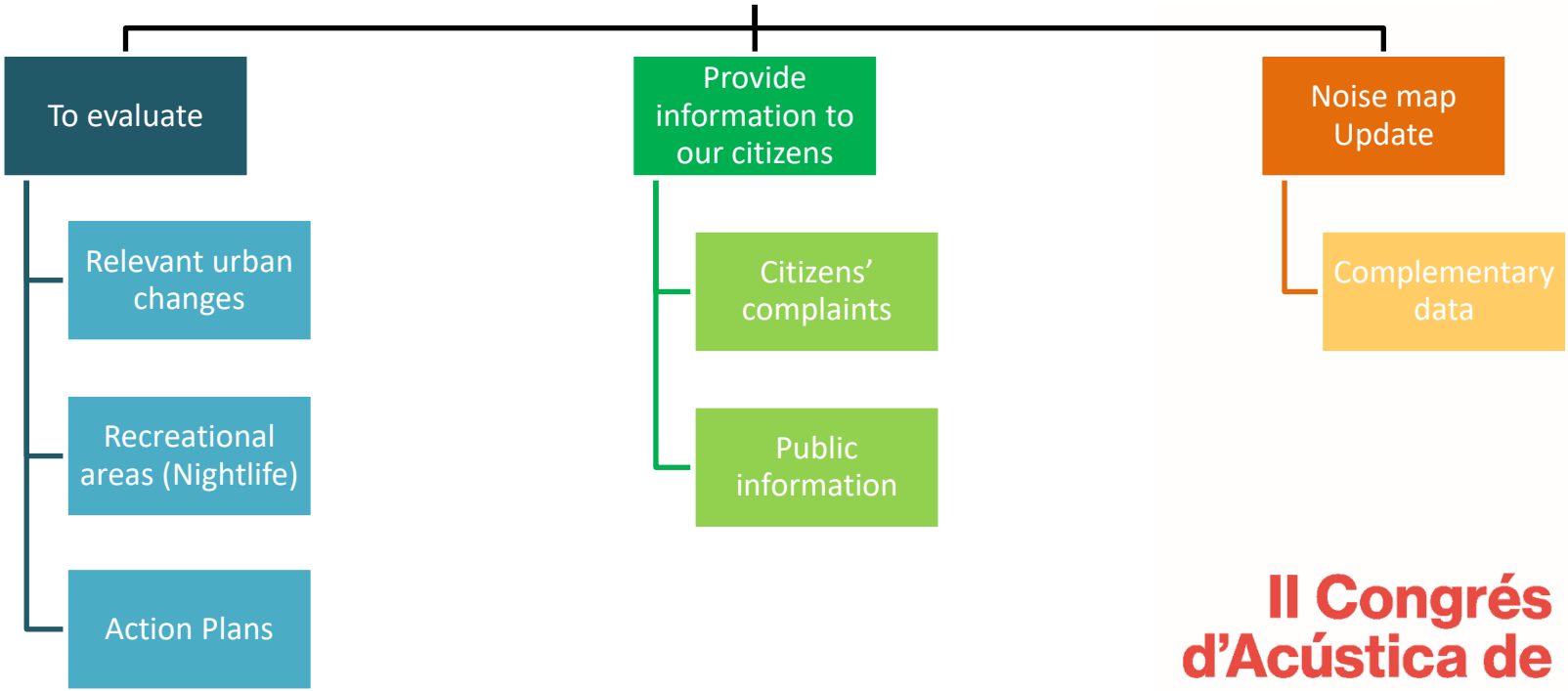
Index

- Strategy
- Infrastructure
- Data analysis
- Strengths and weaknesses of the BCN NMN
- Issues and challenges to improve the BCN NMN

BCN NMN: Strategy

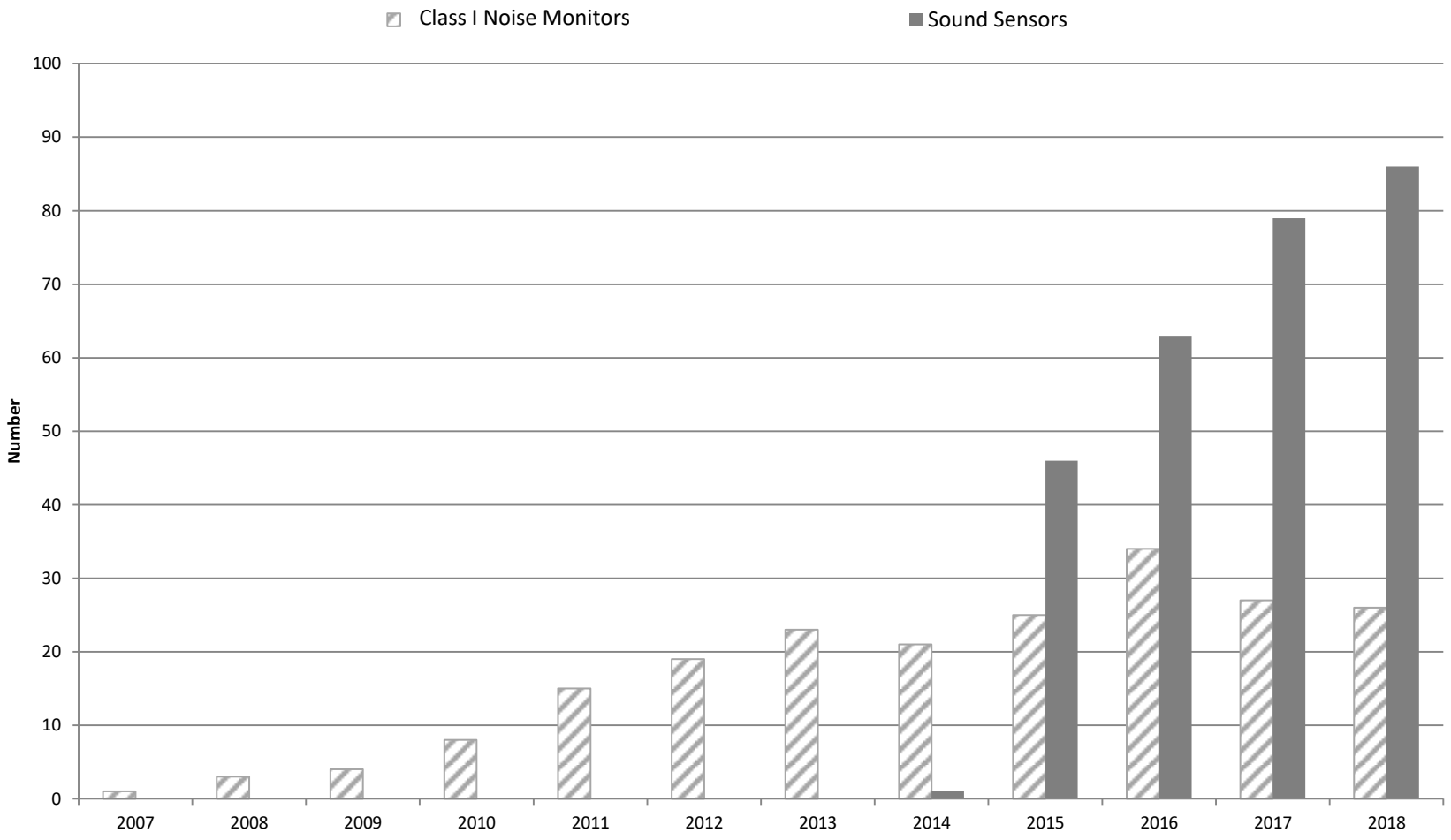
Why do we need a Noise Monitoring Network?



BCN NMN: Infrastructure

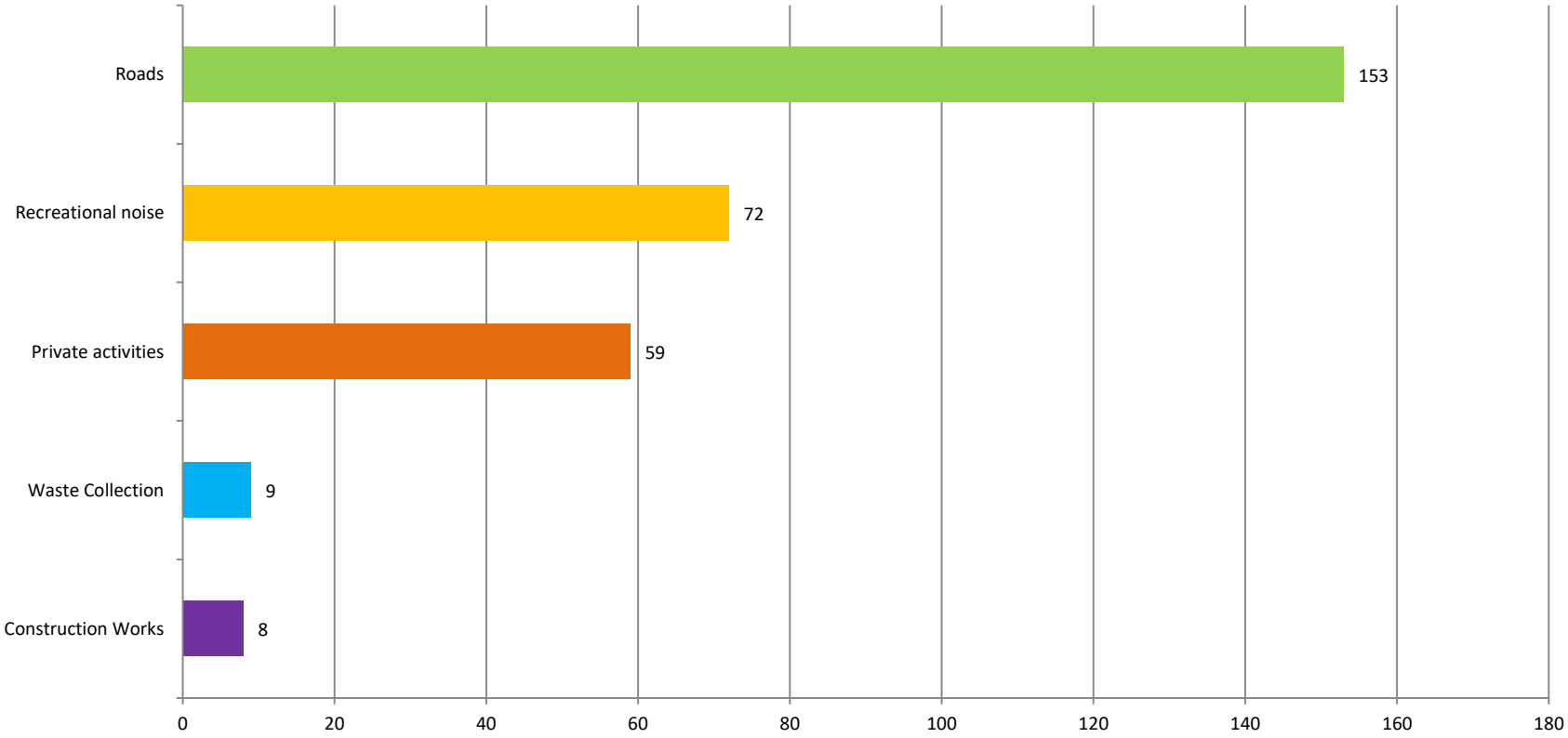
26 Class I noise monitors					86 Sound sensors			
Class I	39 acoustic parameters (Spectrum)	Integration time: 1 second	Measure range: 23-137 dB(A)	Audio recording	Class II	1 acoustic parameter (LAeq)	Integration time: 1 minute	Measure range: 40-100 dB(A)

BCN NMN: Infrastructure



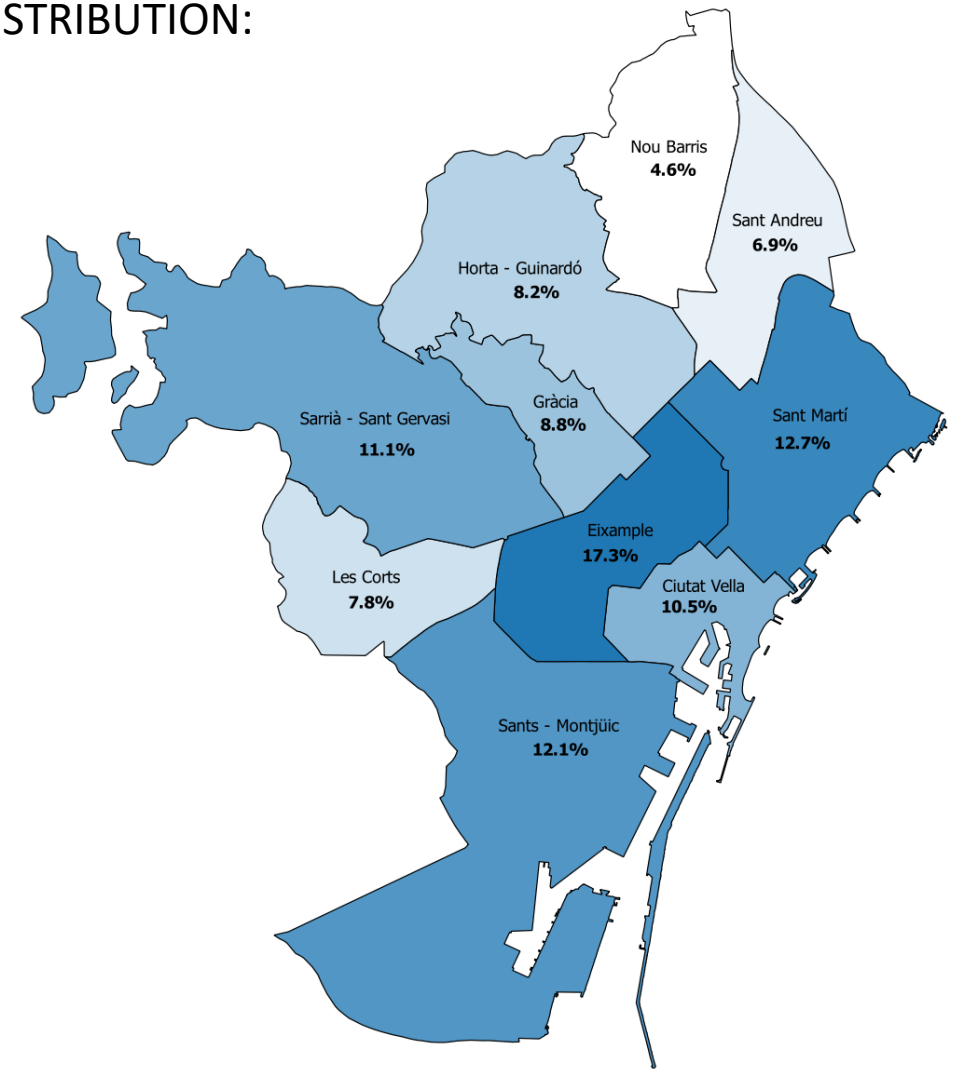
BCN NMN: Infrastructure

Sound sources monitored since 2007

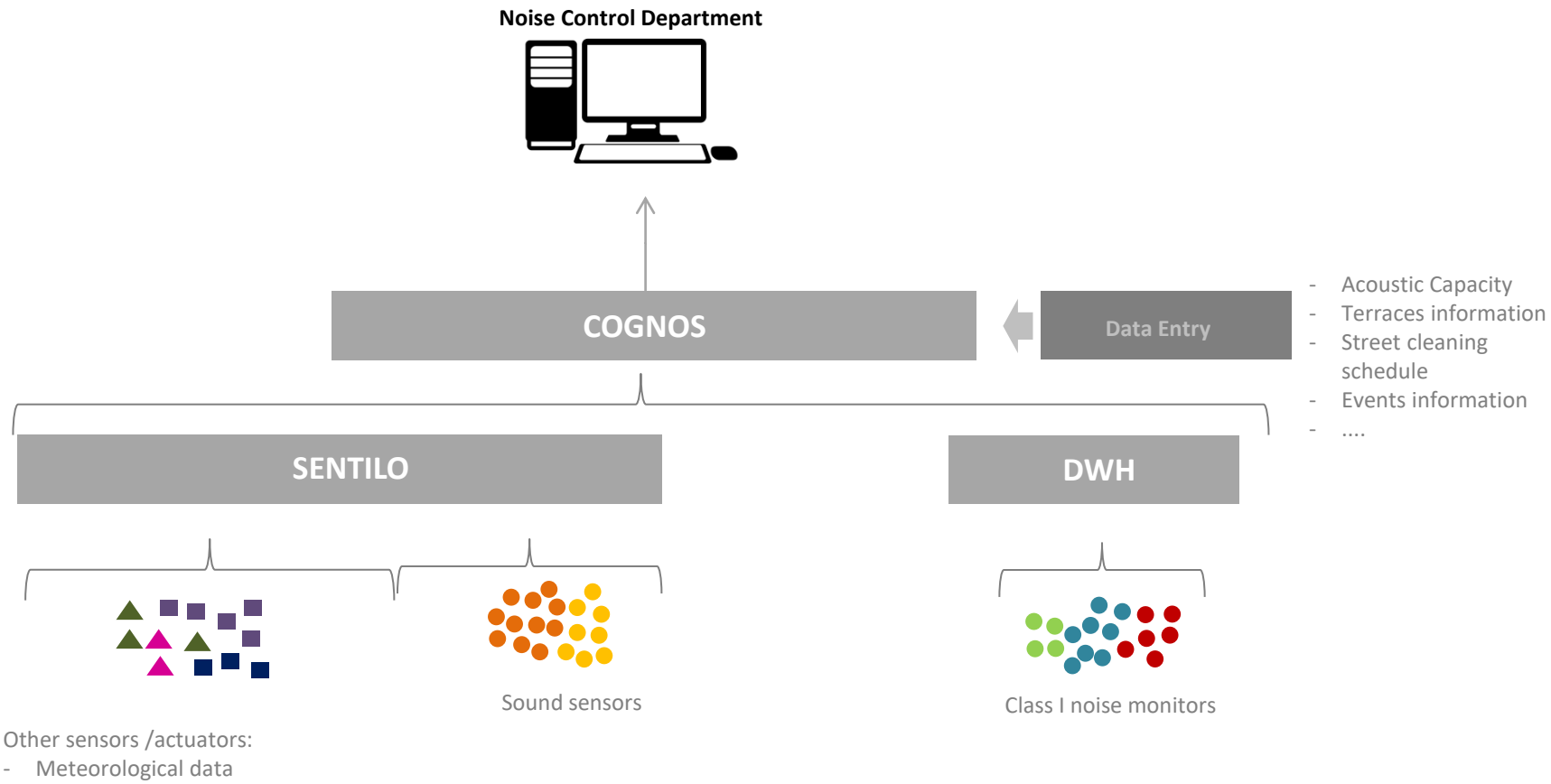


BCN NMN: Infrastructure

TERRITORIAL DISTRIBUTION:

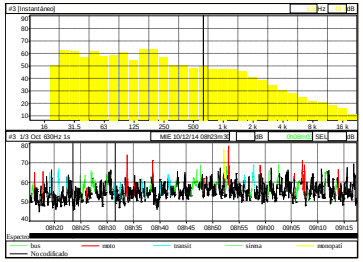


BCN NMN: Data Analysis

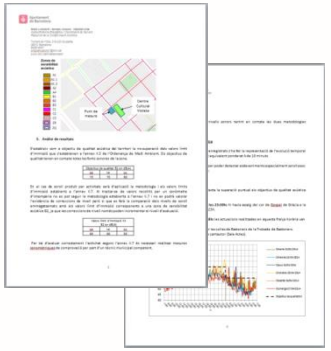


BCN NMN: Data Analysis

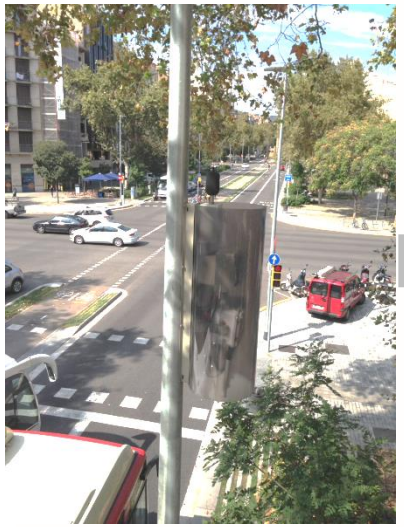
Class 1 sound level meters



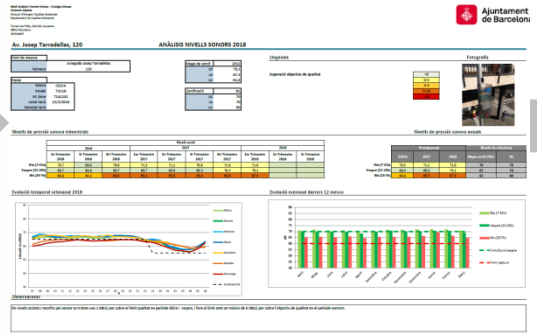
Detailed data analysis



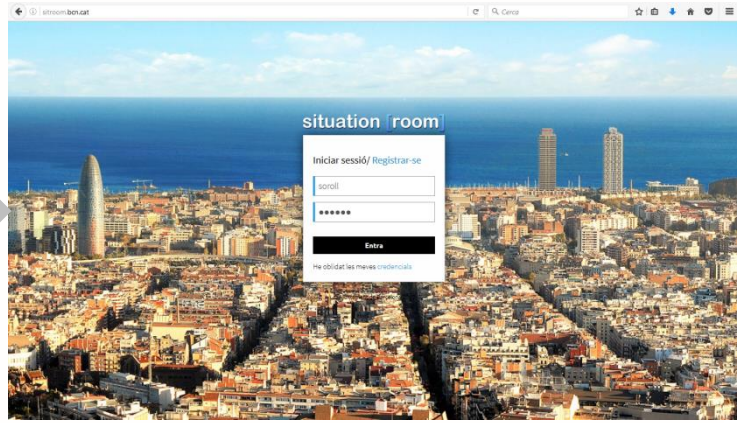
BCN NMN: Data Analysis



Sound sensors



Long term analysis



Situation Room

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BCN NMN: Strengths and weaknesses

- Team performed by **acoustic engineers** specialized on acoustics and data analysis.
- Extended **knowledge** about the city noise and the territory characteristics.
- **Dynamic team on the streets**, which gives quick response making the installation and maintenance tasks.
- Big network with **high number of measuring** points
- **Good distribution** of the measuring points over the territory
- Data analysis **own software**

BCN NMN: Strengths and weaknesses

- High volume and **weight** of the devices
- Need to **increase** the number of measuring points
- Slow and **complex data collection and analysis** system
- **Big amount of data** collected
- Information distributed in **different databases**.
- Severe lack in the **maintenance and failures management.**
- High **maintenance cost** of the entire network.
- **Poor uniformity** between the different measuring point

BCN NMN: Issues and challenges

EQUIPMENT AND INSTALLATION:

- Buy only equipment adapted to the **BCN Sentilo** protocol
- Create a good-practices document to **unify the installations method** on the streets
- Redistribute the devices to **reduce the maintenance costs**
- **Substitute the heaviest devices** for lighter ones.

BCN NMN: Issues and challenges

DATA DOWNLOAD AND ANALYSIS

- Create a **unique software** for all the NMS processes in order to have all the information in the same database.
- **Automatize** all manual processes.
- Use software to easily share the information with other departments in order to increase the internal coordination

BCN NMN: Issues and challenges

FAILURES AND PERIODICAL MAINTENANCE

- Automatize the **failures detection**
- Create an **internal manual** for failures management.
- **Reduce the costs** of the NMS maintenance

INTERNAL INFRASTRUCTURE

- Create a fix team to manage the NMS

The DYNAMAP project experience

- Rosa Ma. Alsina -

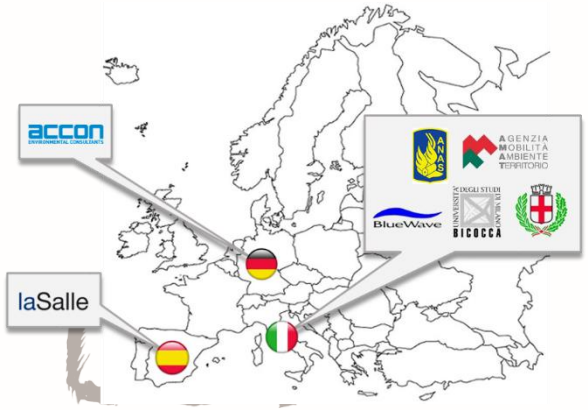
- Noise measurements in urban and suburban environments: **specific noise sources**? Leisure, traffic, road-traffic, other transportation…?
- Monitoring reliable **road traffic noise mapping**
- Extensive WASN use case in urban and suburban acoustic environments (24 sensors each pilot)
- Distributed acoustic signal processing (real-time in the sensor)
- Possible use of categorized noise sources for noise management (leisure, traffic, etc.) depending on the location

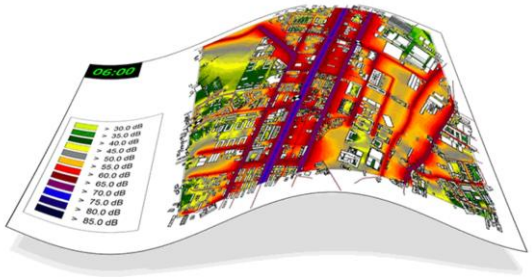
The DYNAMAP project experience

- **DYNAMAP**: Dynamic Acoustic Mapping - Development of low cost sensors networks for real time noise mapping
  - Aimed at developing a dynamic noise mapping system able to detect and represent in real time the acoustic impact of **road infrastructure** → only **road-traffic noise**
  - Main objective**:** ease and **reduce the cost** of periodically updating noise maps, as required by the END on environmental noise.

DYNAMAP
DYNAMIC ACOUSTIC MAPPING

http://www.life-dynamap.eu/





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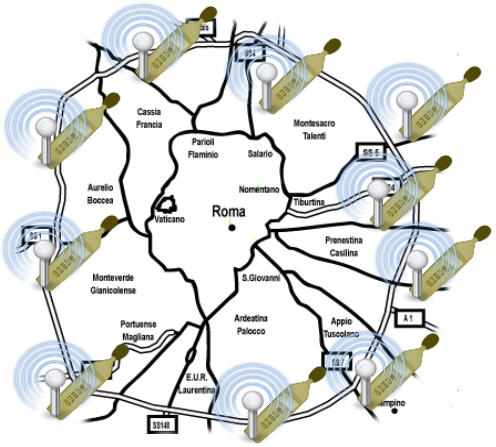
Project Funded by the EU in program LIFE+ 2013 (ENV/IT/001254)
Period: 07/2014 – 06/2019

The DYNAMAP project experience

DYNAMAP's WASN

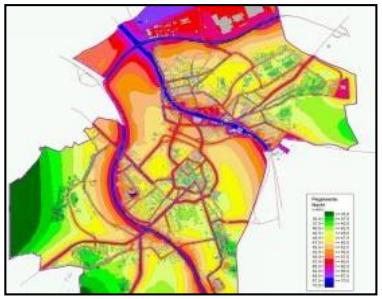
WASN deployment

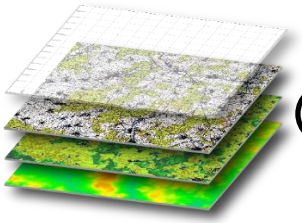


Computed data sent to a server. LA_{eq} + RTN/$\overline{\text{RTN}}$ sent from the sensor to the server every second

Data analysis for calculation of LA_{eq} values of specific sources:
1 - Identification and removal of **anomalous noise events (ANE)**
2 - Calculation of sound level on a predefined time basis

Noise Maps





Geographical Information System (GIS)

Pre-calculated spatial noise map of Source 1

Pre-calculated spatial noise map of Source n

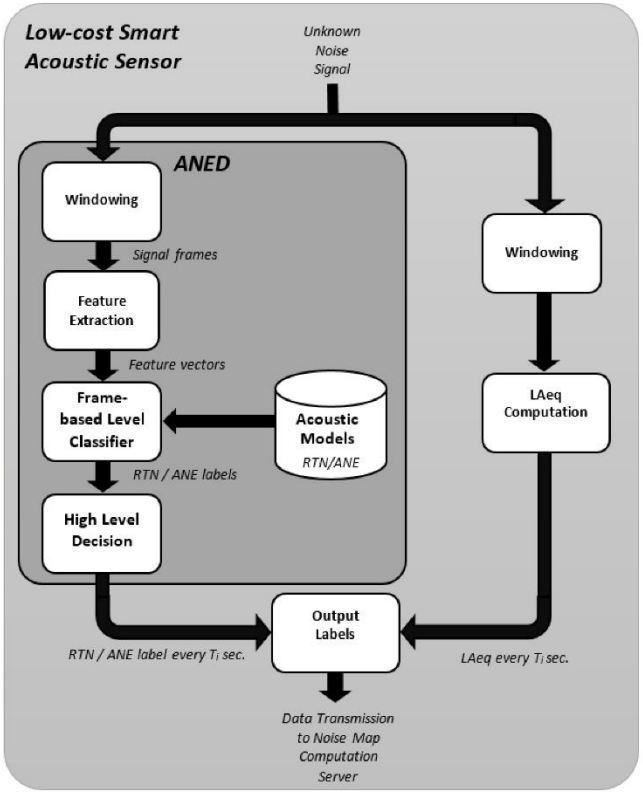
Noise modelling software

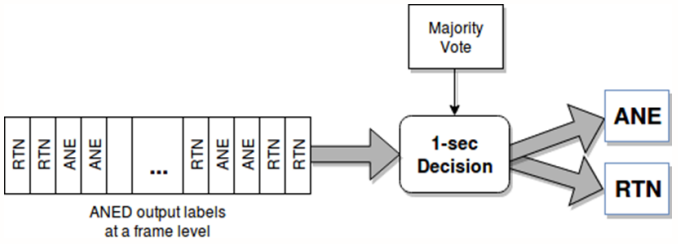
Sound level of node 1

Sound level of node n

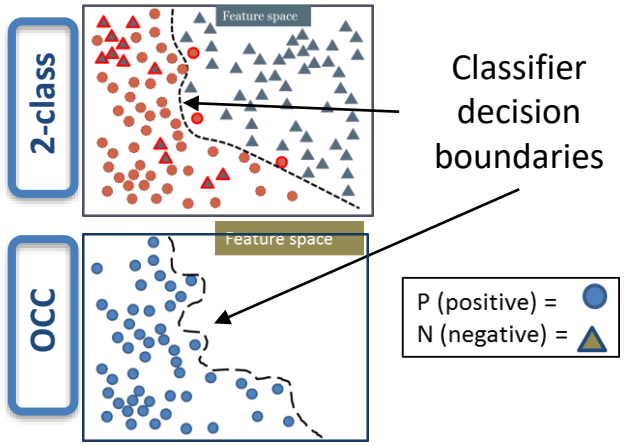
The DYNAMAP project experience

- **Anomalous Noise Event Detector** (ANED)
  - An algorithm designed to identify ANE that could distort the noise levels measured by the acoustic sensors of the network.





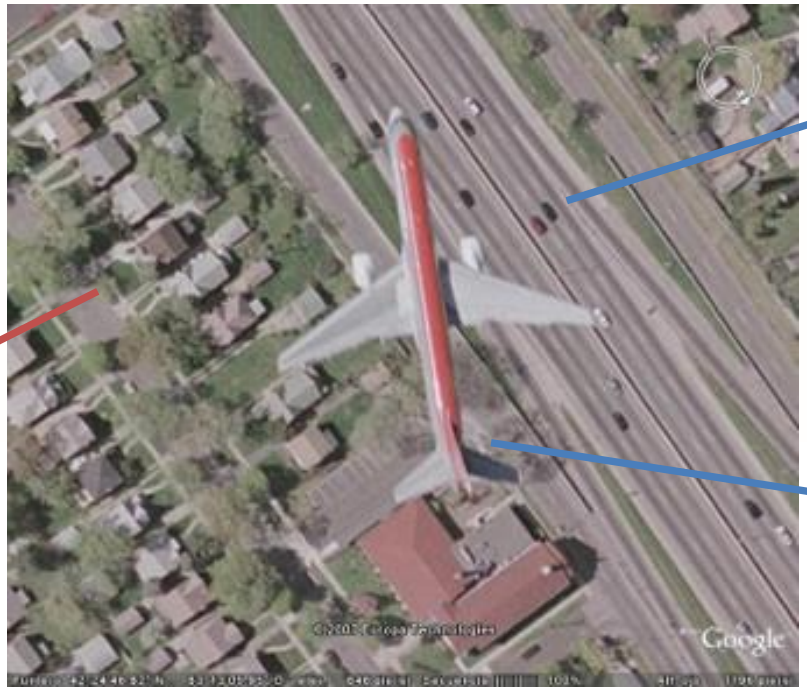
- 2-class vs. one class classification (OCC) approach, only based on majority class



Source: J.C. Socoró, F. Alías, R.M. Alsina-Pagès; "An Anomalous Noise Events Detector for Dynamic Road Traffic Noise Mapping in Real-Life Urban and Suburban Environments", Sensors, 17(10), 2323; doi:10.3390/s17102323 2017

The DYNAMAP project experience

- Example of coexisting noise sources



Noise from road traffic?

- Complex acoustic environment → key to model it appropriately

The DYNAMAP project experience

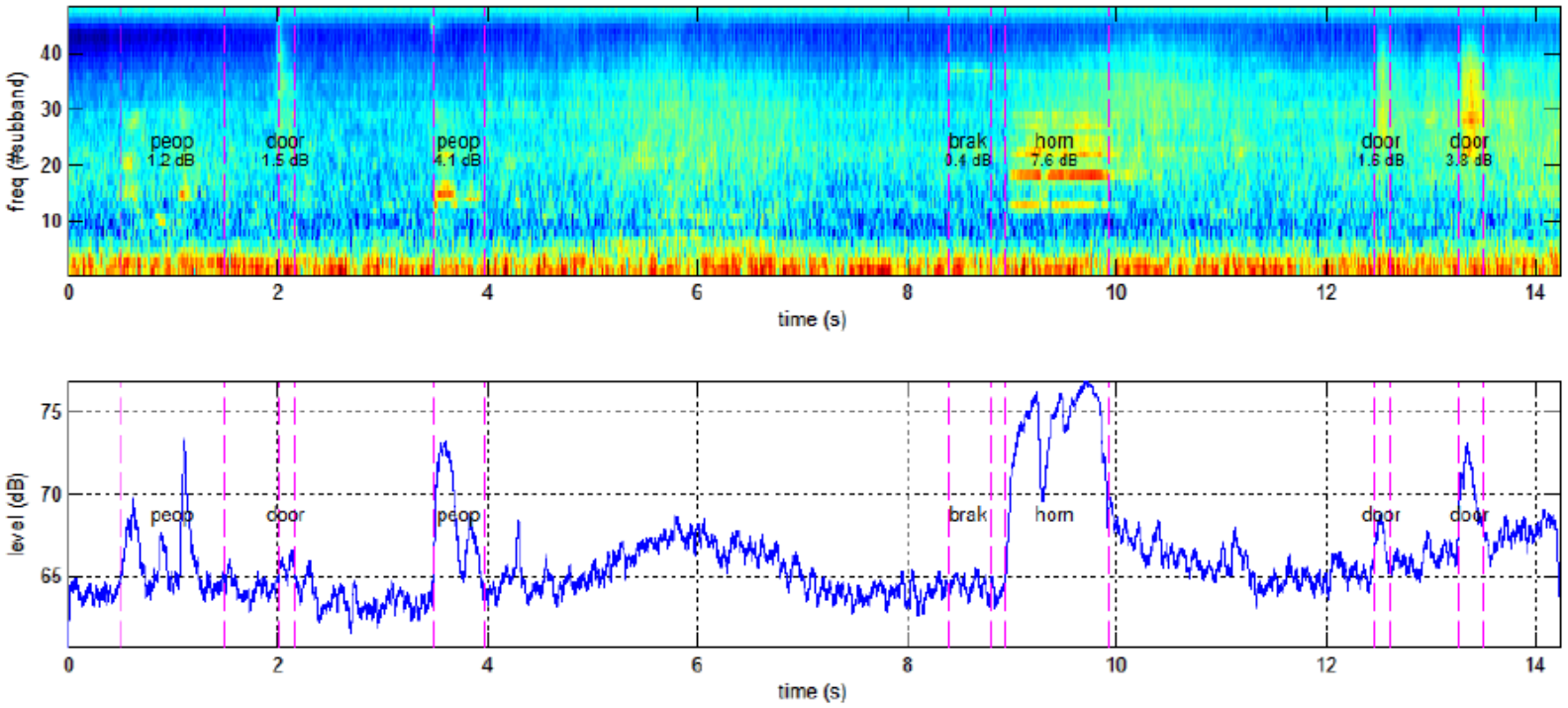
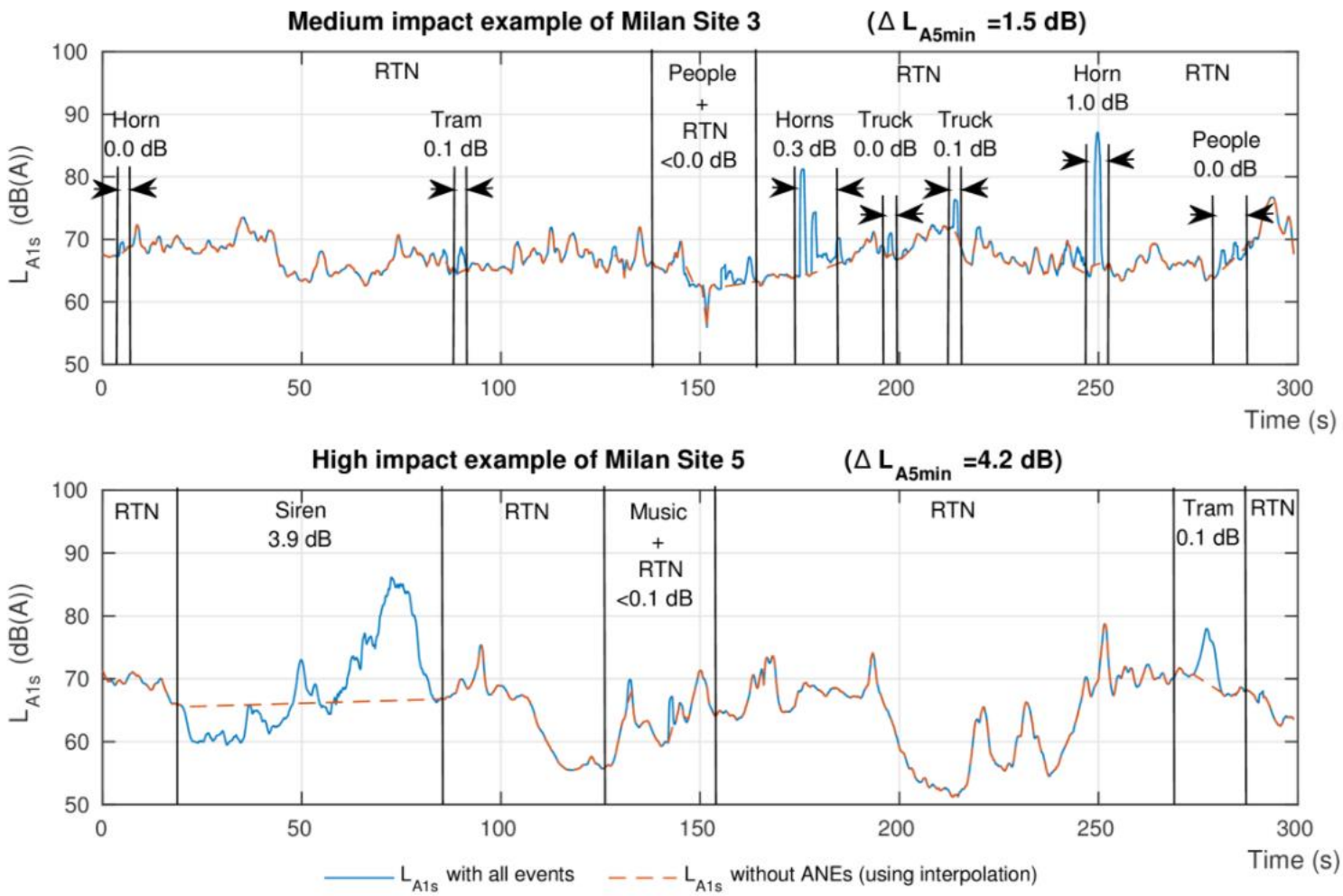


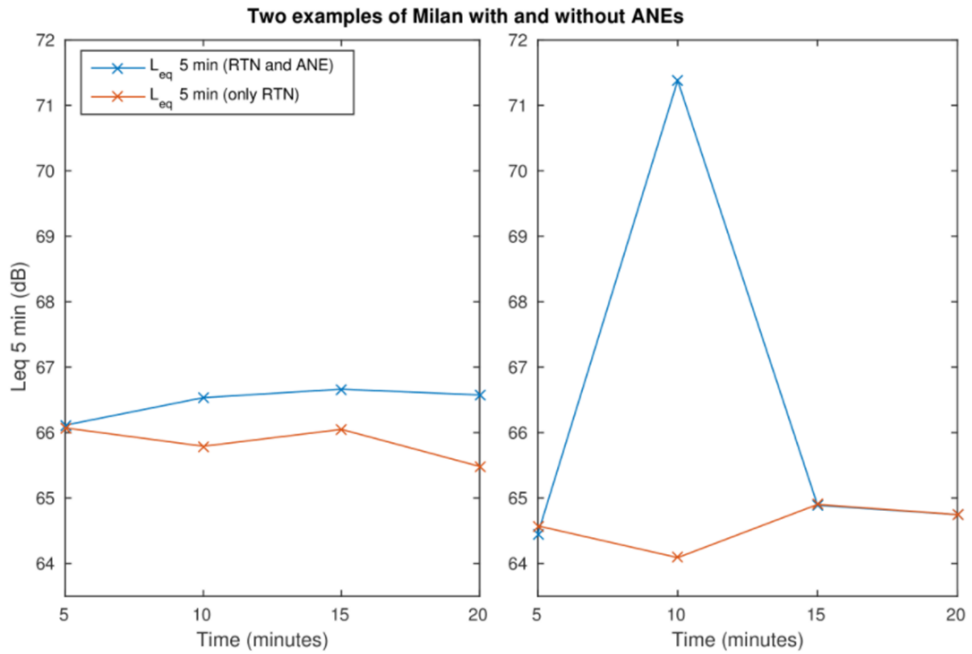
Figure A1. Example with up to seven ANEs obtained in a two-way street with two lanes each way in the urban scenario (city center of Milan). GTCC-based spectrogram (upper) and A-weighted equivalent noise levels (bottom) are shown.

The DYNAMAP project experience



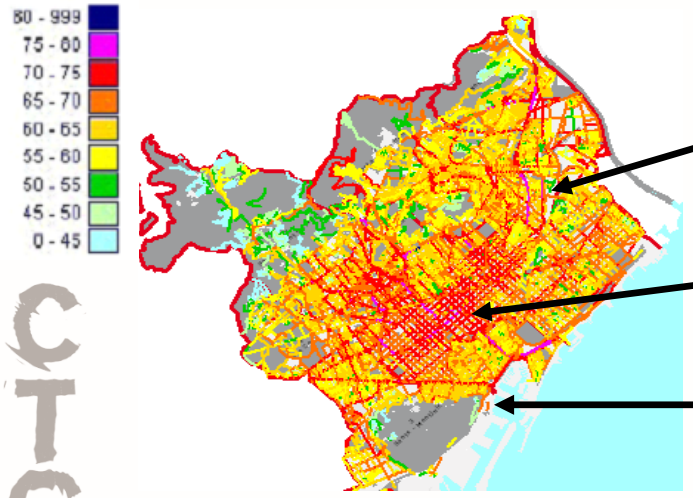
The DYNAMAP project experience

- The impact of non-traffic related events is not negligible.



The DYNAMAP project experience

- Several categories of noise contribution can be quantified if the sound sources can be distinguished
  - more detailed information for noise management
    - Not only the L_{Aeq} value, but also the source category



Road-traffic noise

Leisure noise

Industrial noise

Thank you for your attention!

Rosa Ma Alsina-Pagès, ralsina@salleurl.edu

Grup de recerca en Tecnologies Mèdia

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