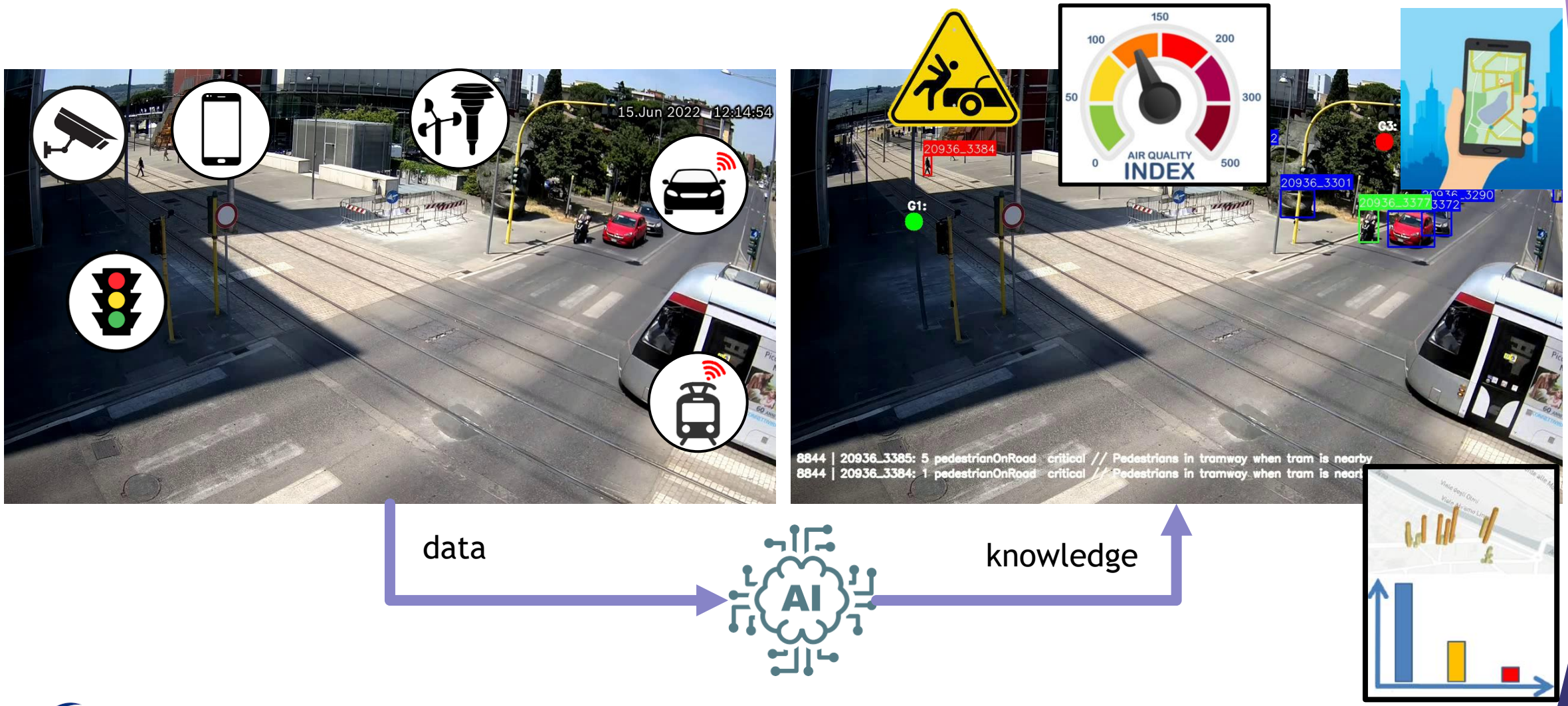
Edge computing for safe and clean mobility in smart cities

Elli Kartsakli

(Senior Researcher at BSC,

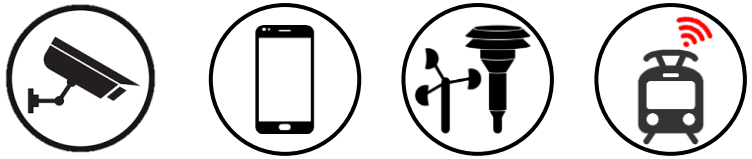
elli.kartsakli@bsc.es)

Smart city: from IoT data to knowledge



AI and data analytics

Key enabling technologies

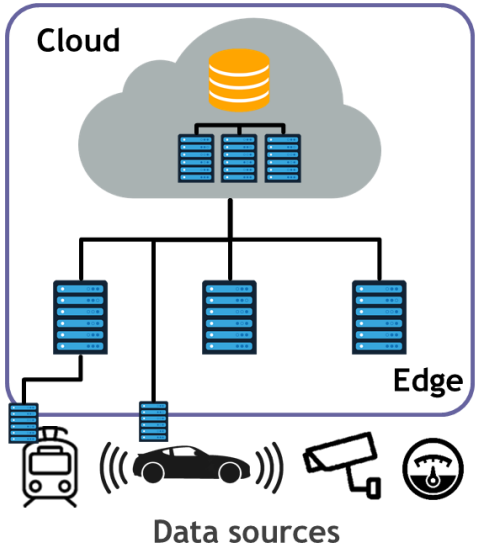


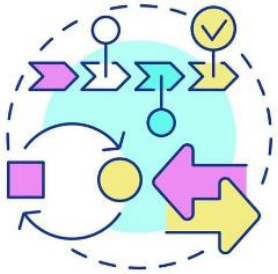
IoT

edge computing

AI and big data

communications





Roadmap

AIR URBAN

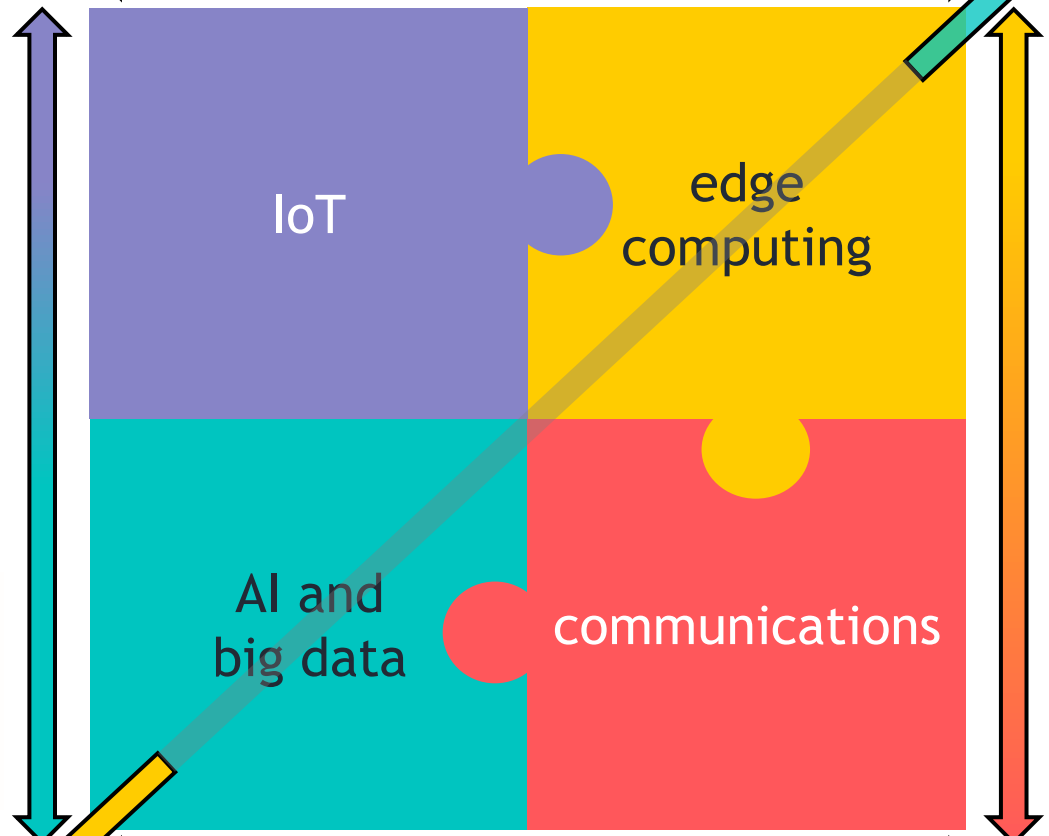
IoT and AI-enabled digital transition towards clean and safe urban mobility

Data mining lifecycle management

EXTRACT

A distributed data-mining software platform for extreme data across the compute continuum

Process sensor data closer to the data sources



AI-based applications

Deliver reliable services to the end users

AI-based system optimization

VERGE

AI-powered evolution towards open and secure edge architectures

*Unify computing and communications into a **connected compute continuum** from edge to cloud and HPC*

proximity

A platform for PRogramming, Orchestration and eXecution of real-tIme data analytics workflows for smart and clean MobilITY

Smart City Use Cases

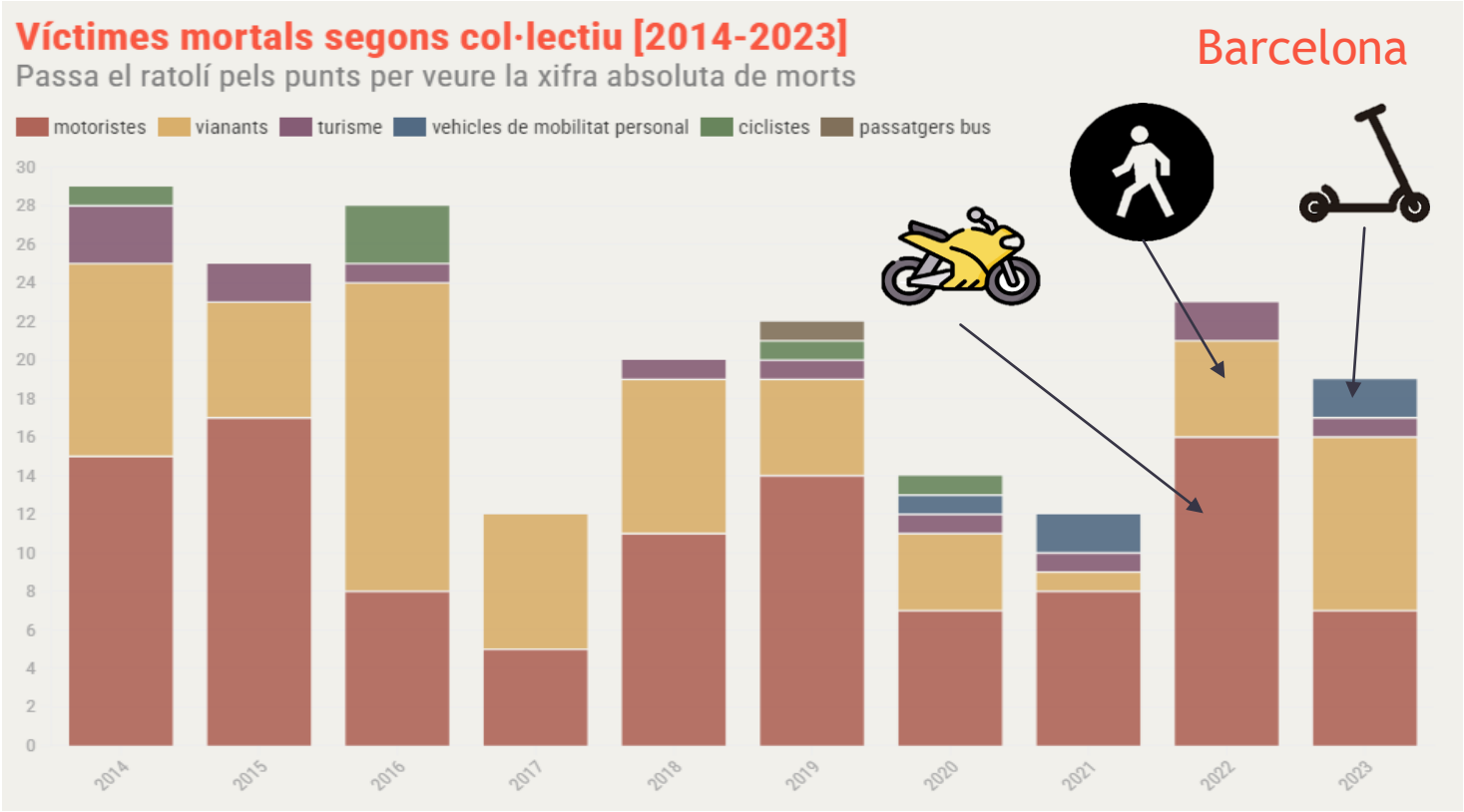
Safe and connected mobility

Urban air quality

Urban crisis management

Use case 1: Safe and connected mobility

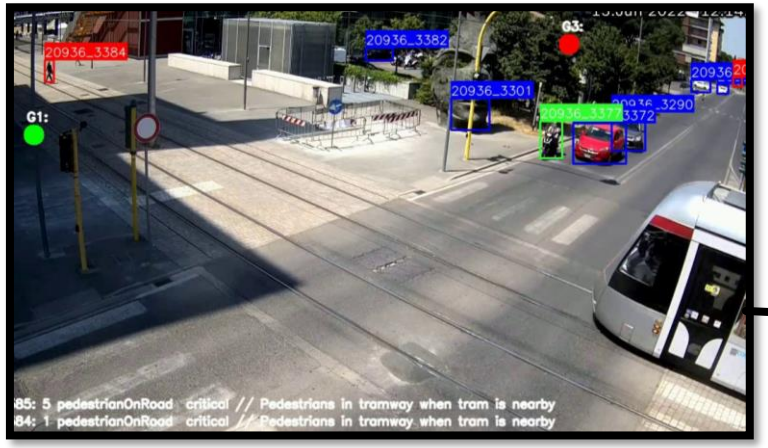
The need for urban safety

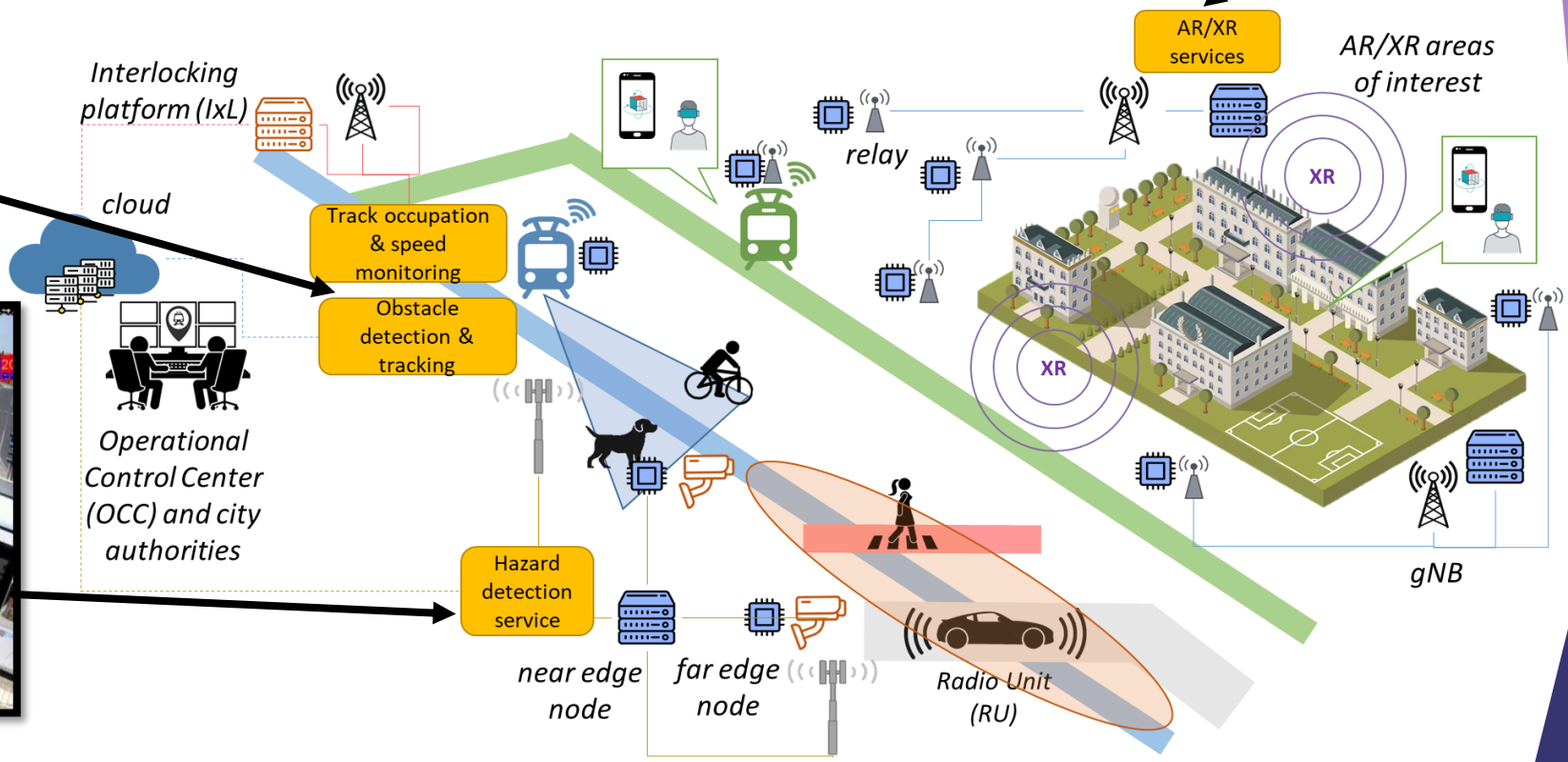


https://beteve.cat/mobilitat/victimes-mortals-accident-transit-barcelona/

≠ VISION ZERO NO MORE TRAFFIC DEATHS

Autonomous tram use case

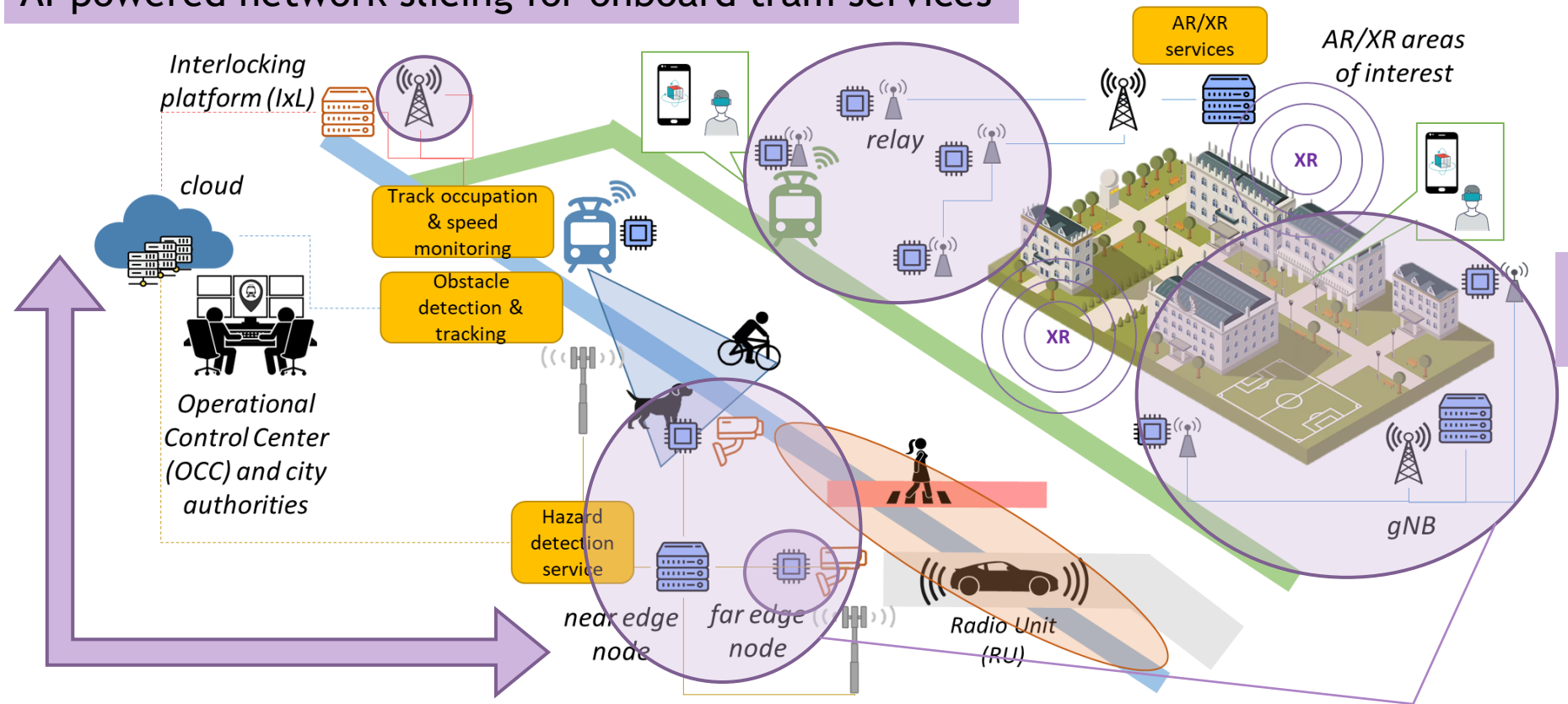




Use case innovations

✓ Data-driven resource optimization (e.g., relay selection for XR services)

AI-powered network slicing for onboard tram services



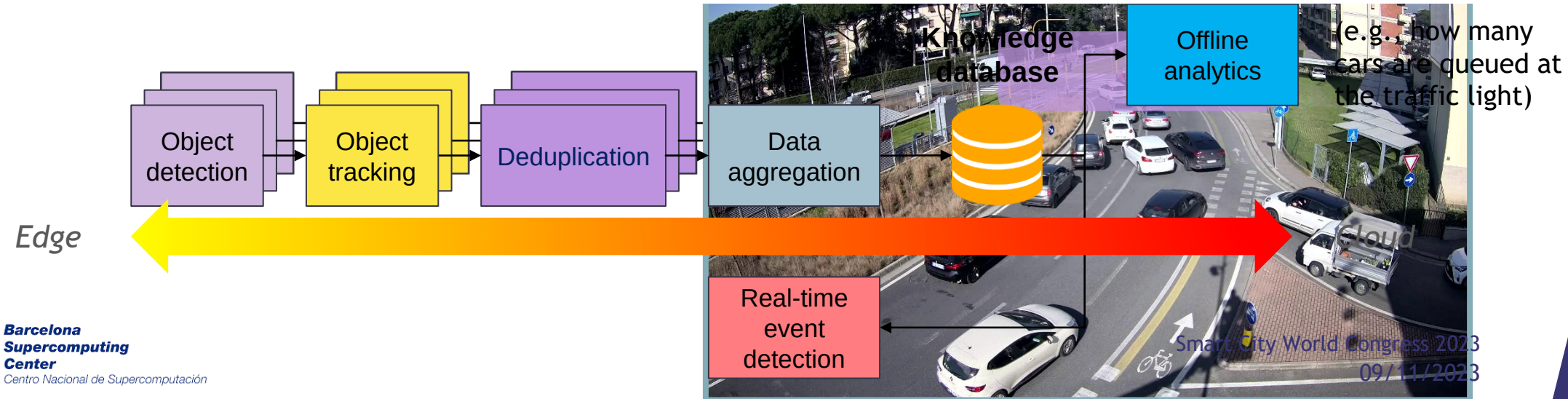
Security, privacy and trustworthiness of AI

Distributed and split computing across edge and cloud

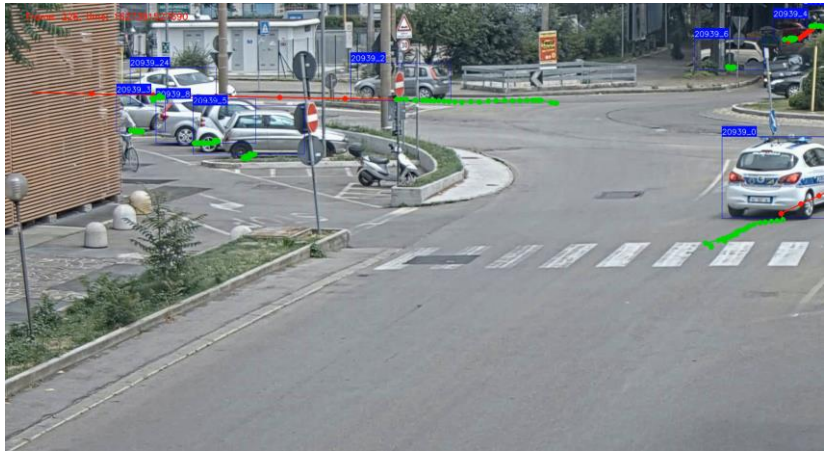
Multi-tier orchestration: intra-node, edge-site, multi-site

Hazard detection service

- ✓distribution of complex workflows across the compute continuum
- ✓end-to-end latency requirements guarantee
- ✓service orchestration for scalability and multi-tenancy

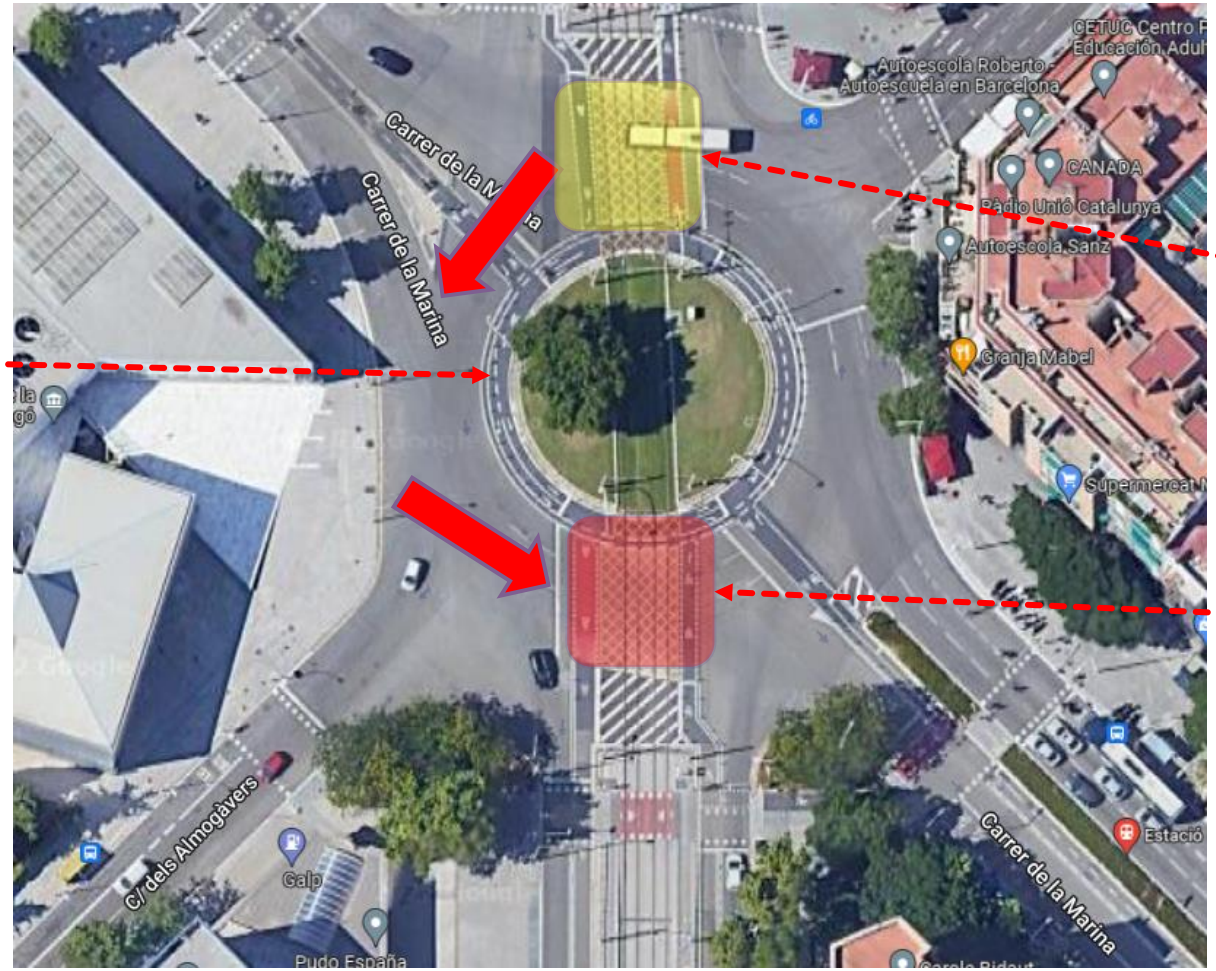


Hazard detection examples



The PROXIMITY pilot in Barcelona

bicycle lanes



Interaction zone between the tram and cars/public bus

Interaction zone between the tram and bicycles

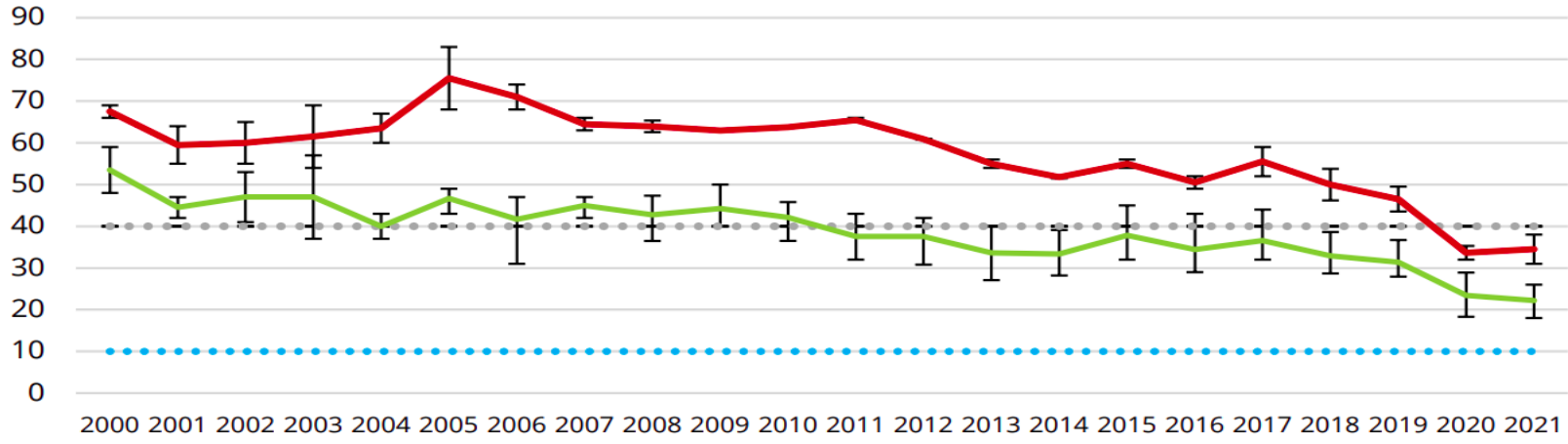
Institut Municipal d'Informàtica

ATM Àrea de Barcelona
Autoritat del Transport Metropolità

Use case 2: Urban air quality

The need for better air quality

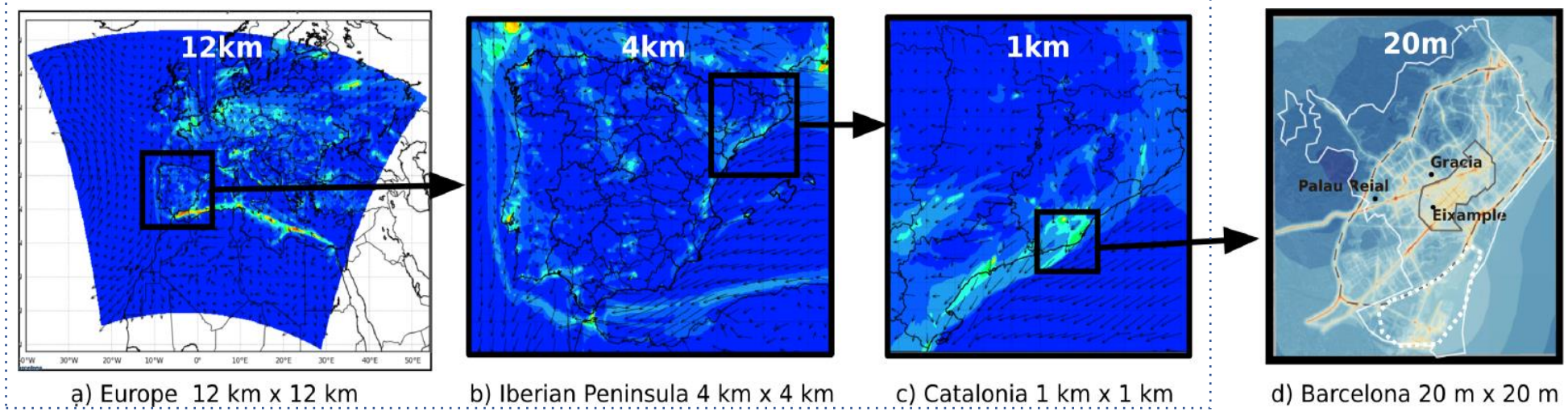
- In 2019, 94% and 97% of the EU urban population were exposed to nitrogen dioxide (NO 2) and particulate matter (PM) concentrations above the World Health Organization guidelines (EEA 2019).
- Barcelona is the sixth European city with the highest mortality burden associated with NO2 (Khomenko et al. 2021)



CALIOPE-Urban: air quality model at street scale

Regional model(1)

Urban model(2)

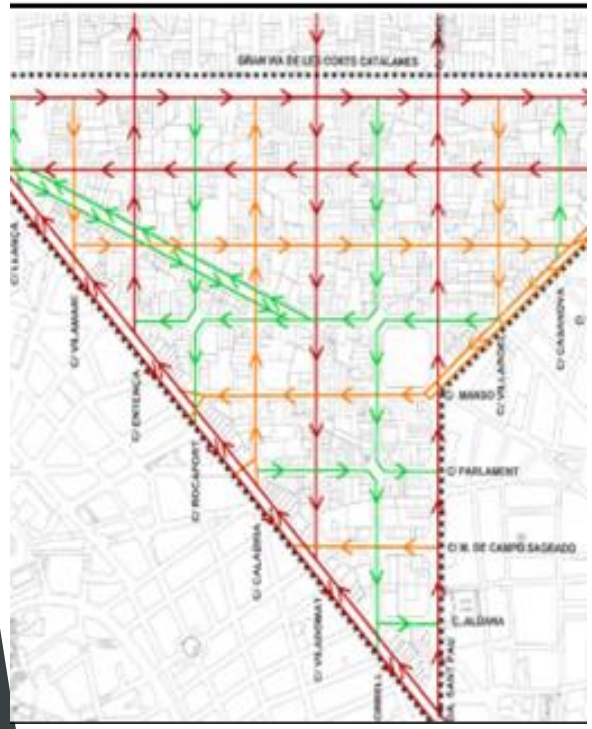


- (1)Soret, A. et al. (2022). Status and Future Vision of the CALIOPE Air Quality Forecasting System: Support for Air Quality Policies. In: Mensink, C., Jorba, O. (eds) Air Pollution Modeling and its Application XXVIII. ITM 2021. Springer Proceedings in Complexity. Springer, Cham. https://doi.org/10.1007/978-3-031-12786-1_23
- (2) Benavides, J., Snyder, M., Guevara, M., Soret, A., Pérez García-Pando, C., Amato, F., Querol, X., and Jorba, O.: CALIOPE-Urban v1.0: coupling R-LINE with a mesoscale air quality modelling system for urban air quality forecasts over Barcelona city (Spain), Geosci. Model Dev., 12, 2811–2835, https://doi.org/10.5194/gmd-12-2811-2019, 2019.

CALIOPE-Urban granularity

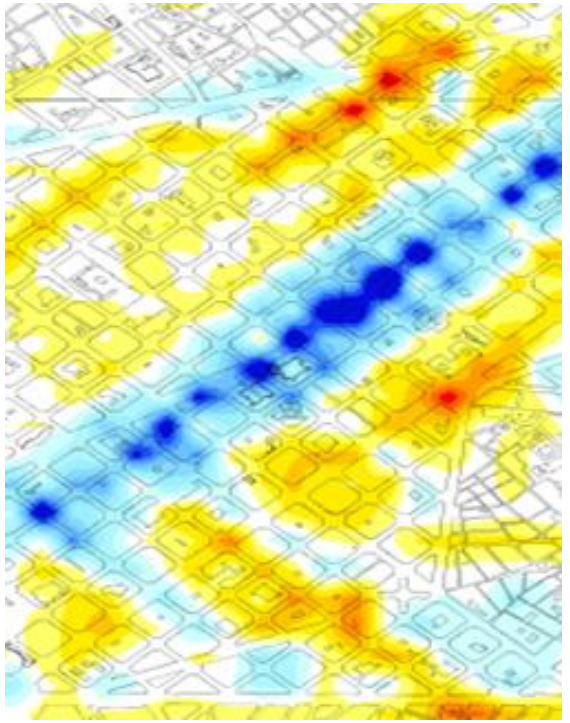
CALIOPE

Urban planning

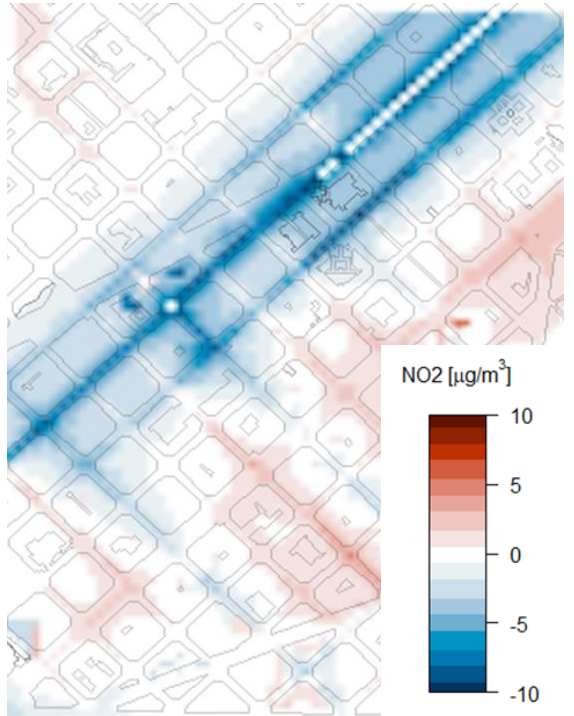


Traffic model

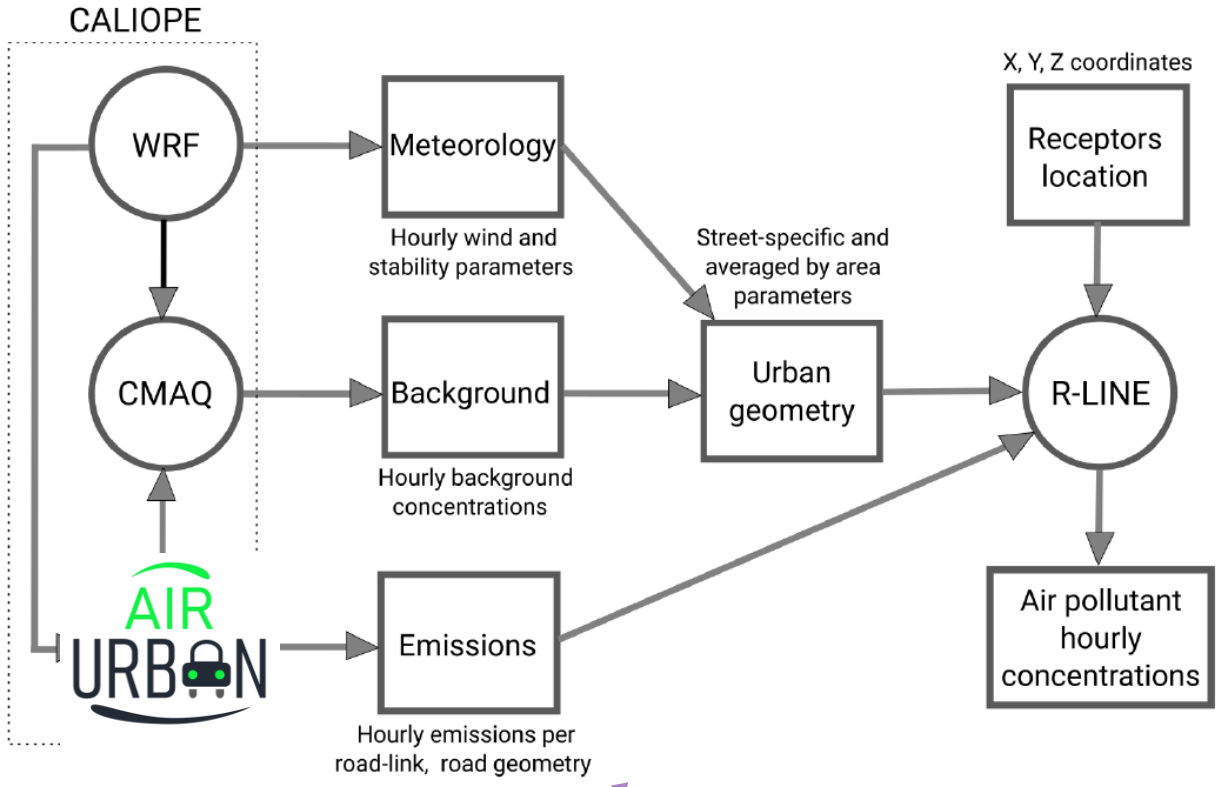
Emission model



Air quality model



AIR-URBAN innovation



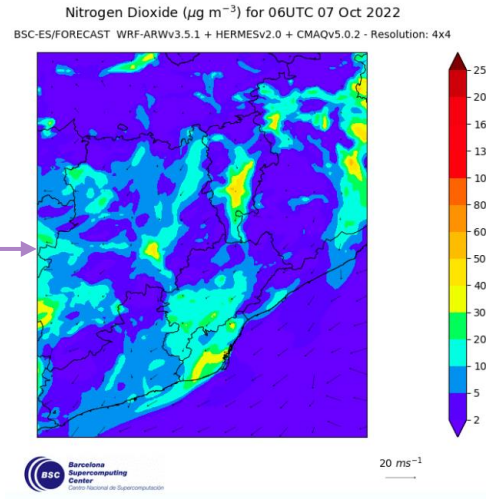
- ✓ emissions estimated based on real-traffic (near-real time scale)
- ✗ emissions calculated through a traffic simulator

Key objectives

AI

vehicle types,
speed,
acceleration

emission model



✓ Enhance air quality forecasting by considering real traffic information in the emission models

✓ Assess the impact of traffic events on air quality

✓Estimate real-time air quality levels based on real traffic data

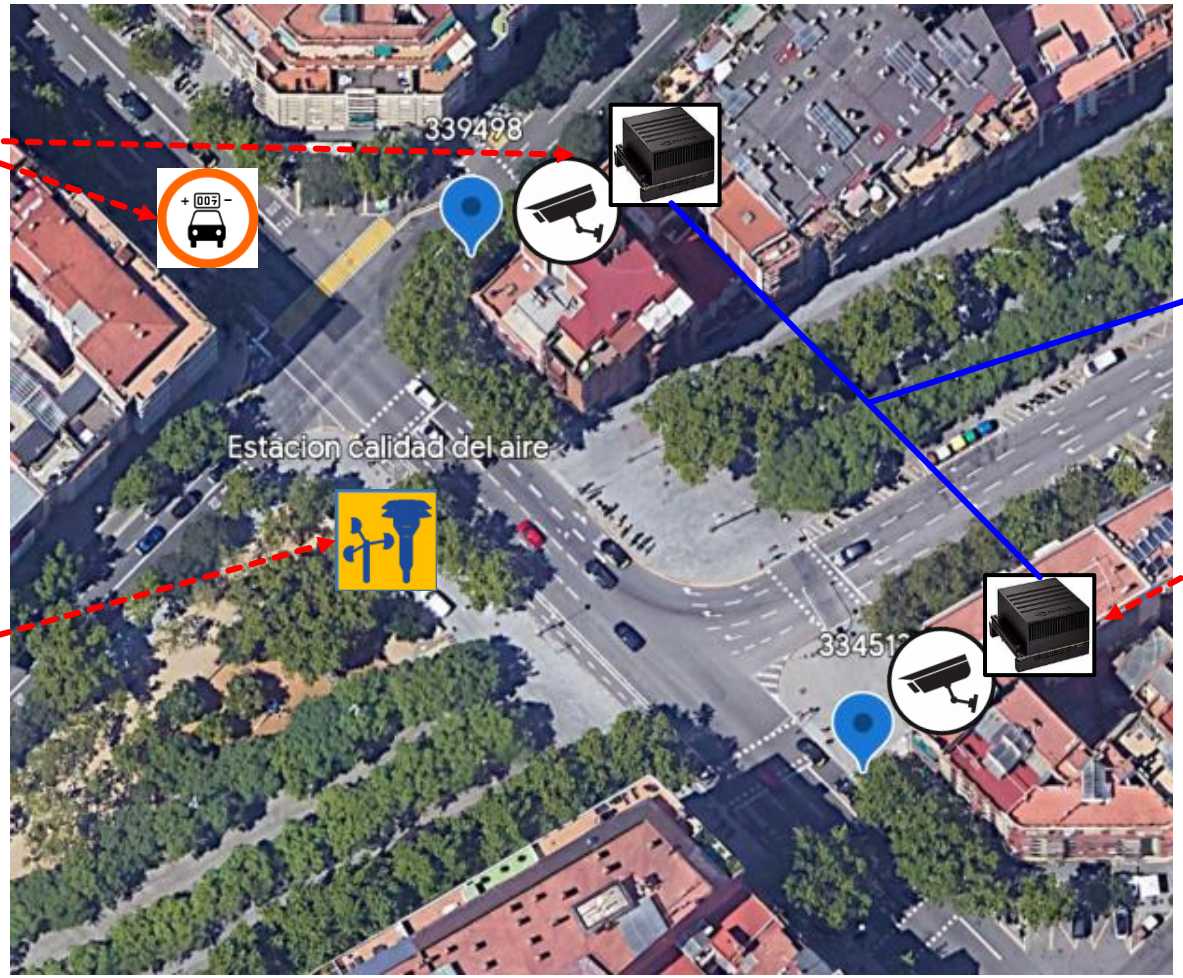
traffic events
(e.g., bus stopped)

Air Quality (AQ) Measurements

AIR-URBAN pilot

IoT infrastructure (cameras and traffic counters)

Air quality measurements (Generalitat de Catalunya)



Supercomputing facilities

BSC

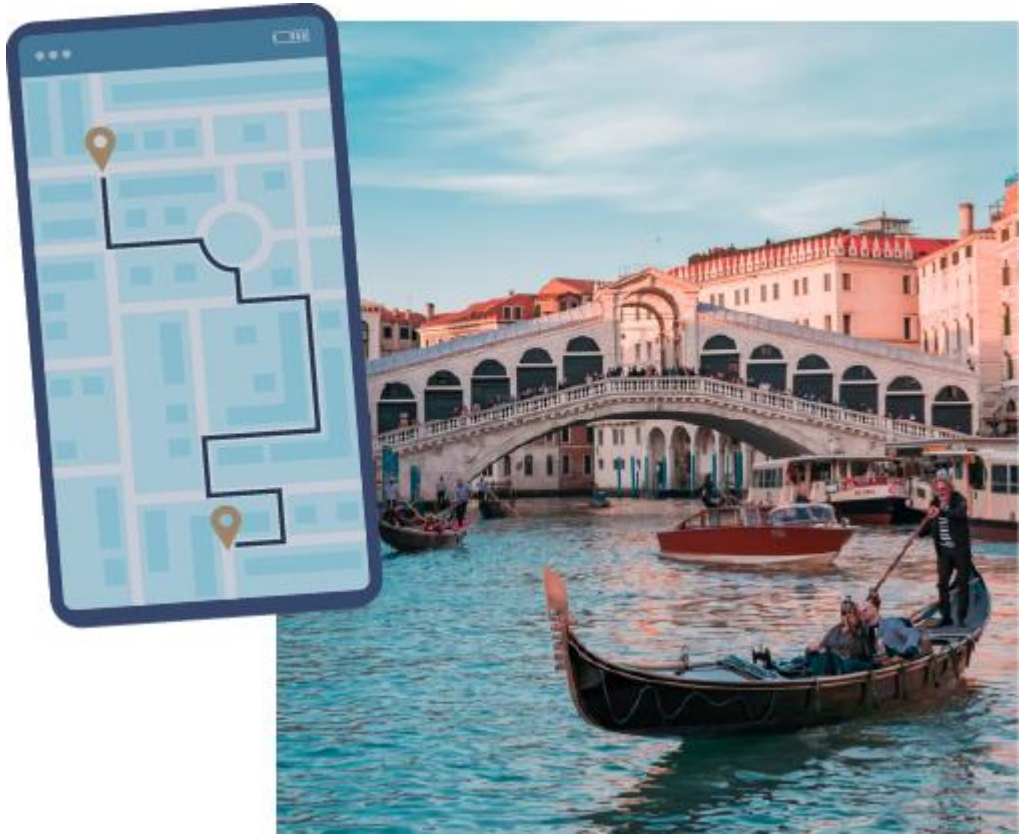
Edge Computing infrastructure

Use case 3: Urban crisis management

EXTRACT

Crisis management challenges in Venice

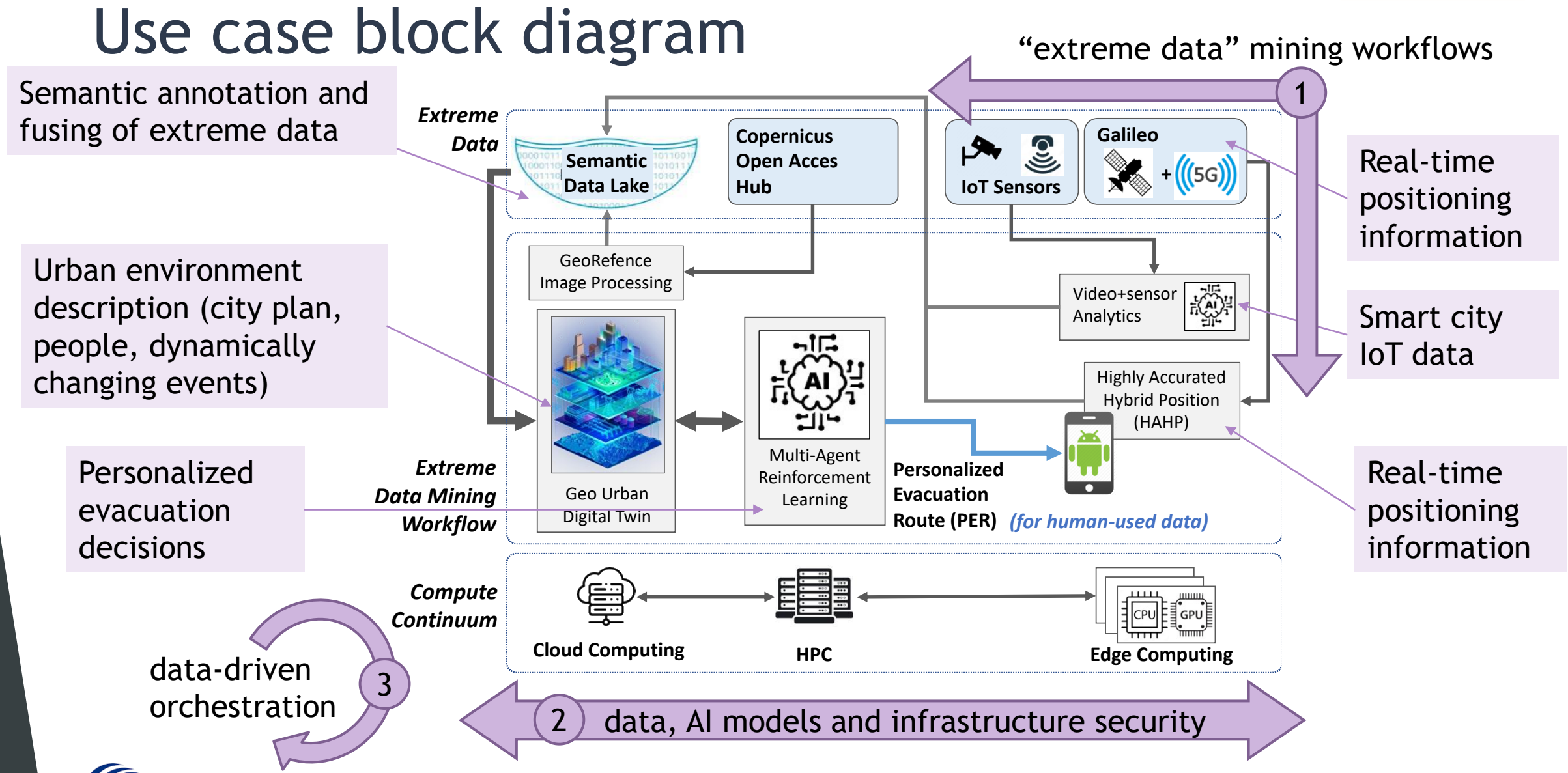
- Venice is a unique city
  - Unique city layout
    - 177 canals, 417 bridges (72 are private)
  - Limited escape routes & accessibility
  - Water level variations (flooding)
  - Massively touristic



The need for a personalized approach

- A plan-for-all may not capture:
  - rapidly changing conditions due to disaster (e.g., fire, blockages, etc.)
  - dynamic evacuation possibilities
  - different walking speeds and limitations of individuals
  - dependencies (e.g., families, pets, etc.)
  - knowledge of the city (locals vs. tourists)
- Challenges:
  - Extreme data from city, satellite imaging, user positioning and requirements
  - Extreme computation for real-time personalized decisions

Use case block diagram



Thank you very much!

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