ELASTIC

A Software Architecture for Extreme-ScaLe
Big-Data AnalyticS in Fog CompuTIng Ecosystems

ELASTIC: A Software Architecture for Advanced Mobility Systems

AI & BIG-DATA CONGRESS (BARCELONA)
15 SEP 2021

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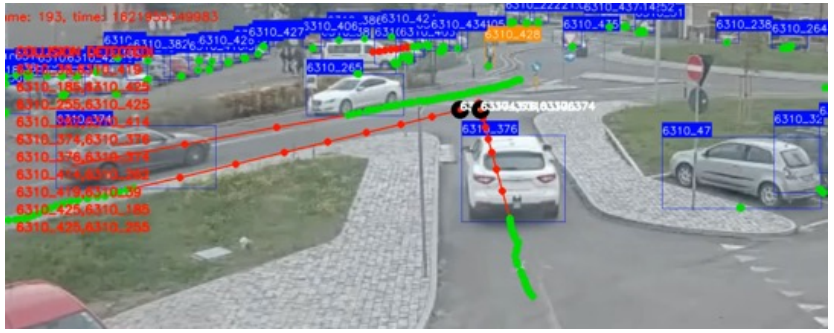
"The ELASTIC project has received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreement No 825473"

General Information

- ELASTIC: a software architecture for **E**xtreme-sca**L**e big-data **A**nalytic**S** in fog compu**TI**ng e**C**osystems
  - Under the scope of the H2020 call ICT-12-2018-2020: *Big Data technologies and extreme-scale analytics*
- 42 month project (starting Dec 2018); 6 million € budget

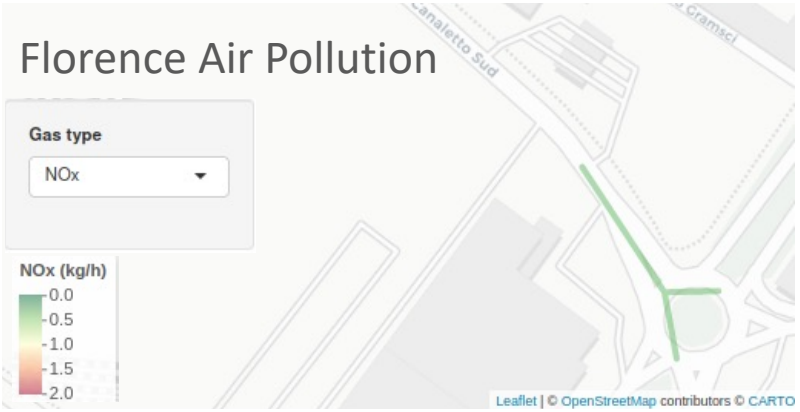
From Data to Real-time Knowledge



Collision Detection

Data → **Knowledge**

Air Pollution Estimation



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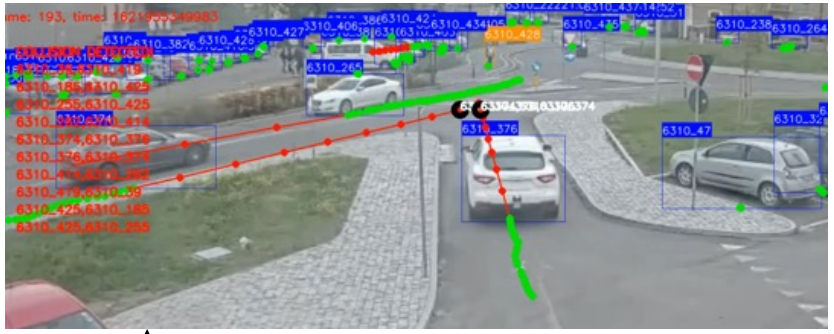


Collision Detection

Knowledge

Air Pollution Estimation

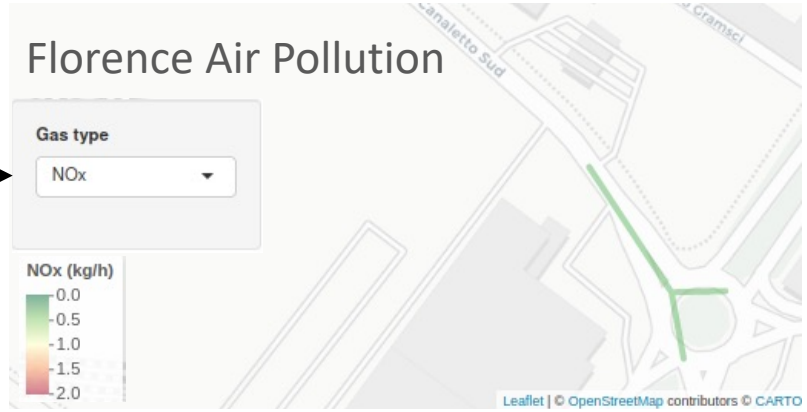
End-to-end response time

Data

Object Detection → Object Tracking → Trajectory Prediction → Collision Detection

Object Tracking → Pollution Emission

Data-Analytics Workflow



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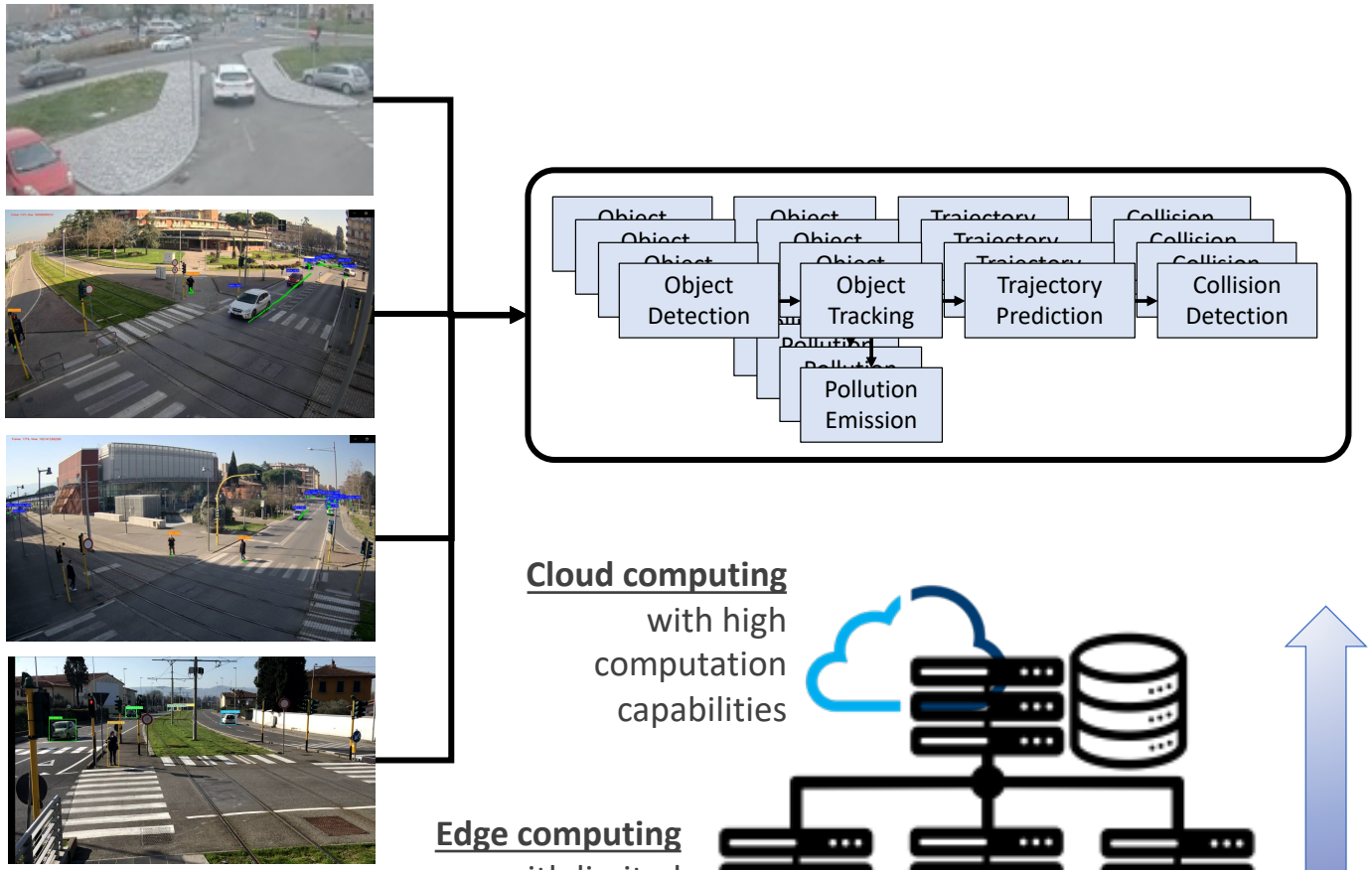
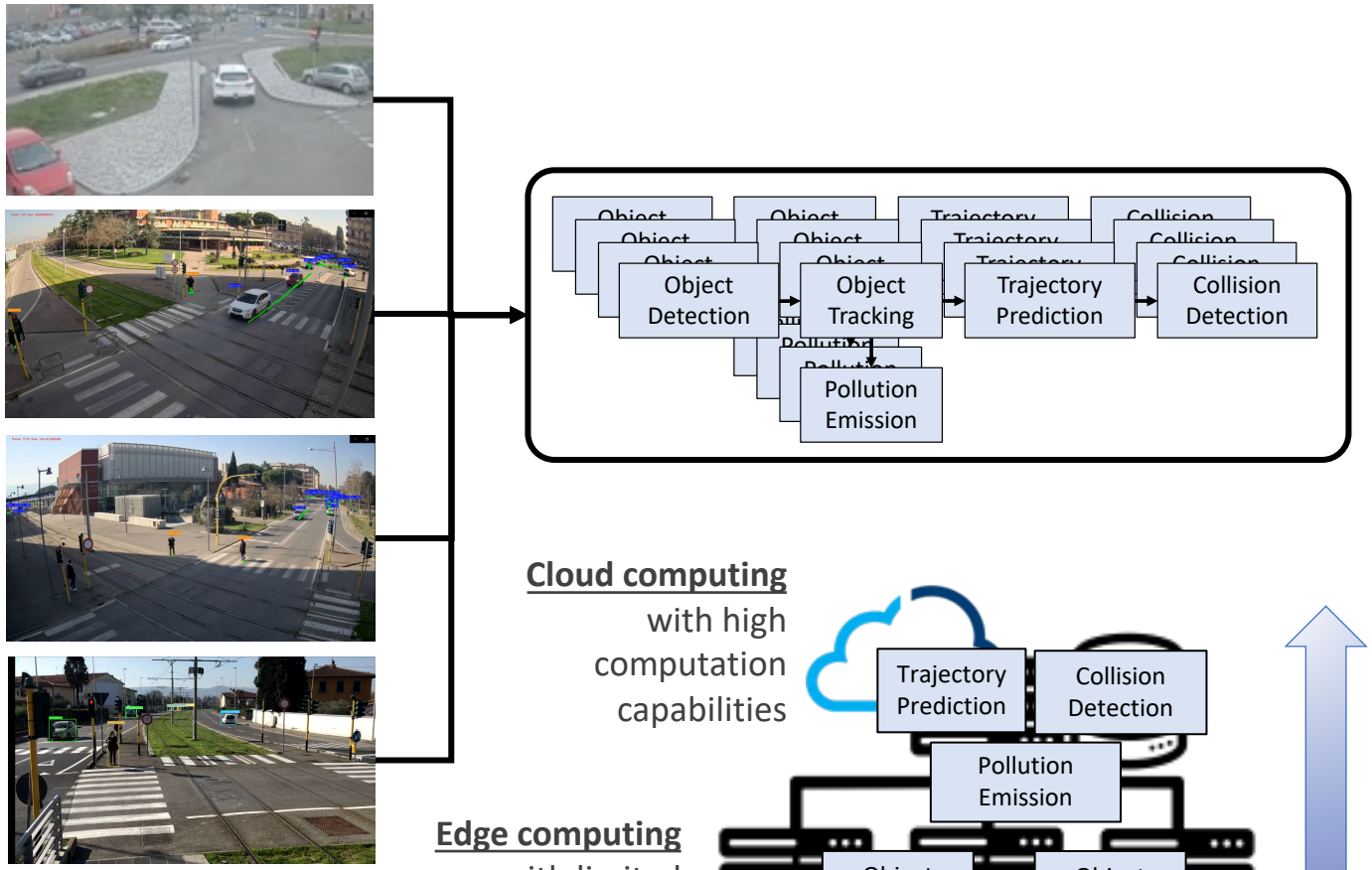


Challenges:

1. **Geographically distributed data sources** with complex data analytics requirements, e.g., smart cities
2. **Compute continuum** infrastructure composed of edge and cloud resources
3. The fulfillment of **non-functional requirements** inherited from the application domain: real-time, energy, communications and security

A coordination of **edge and cloud resources is needed!**

From Data to Real-time Knowledge



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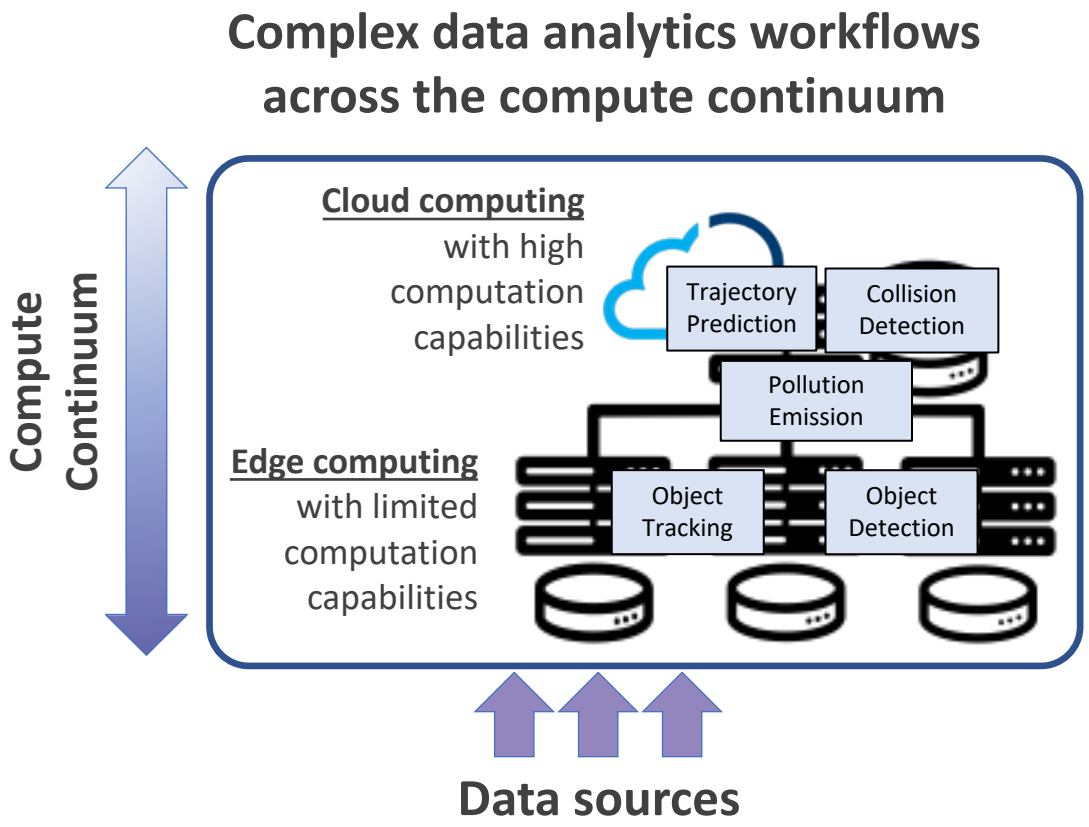
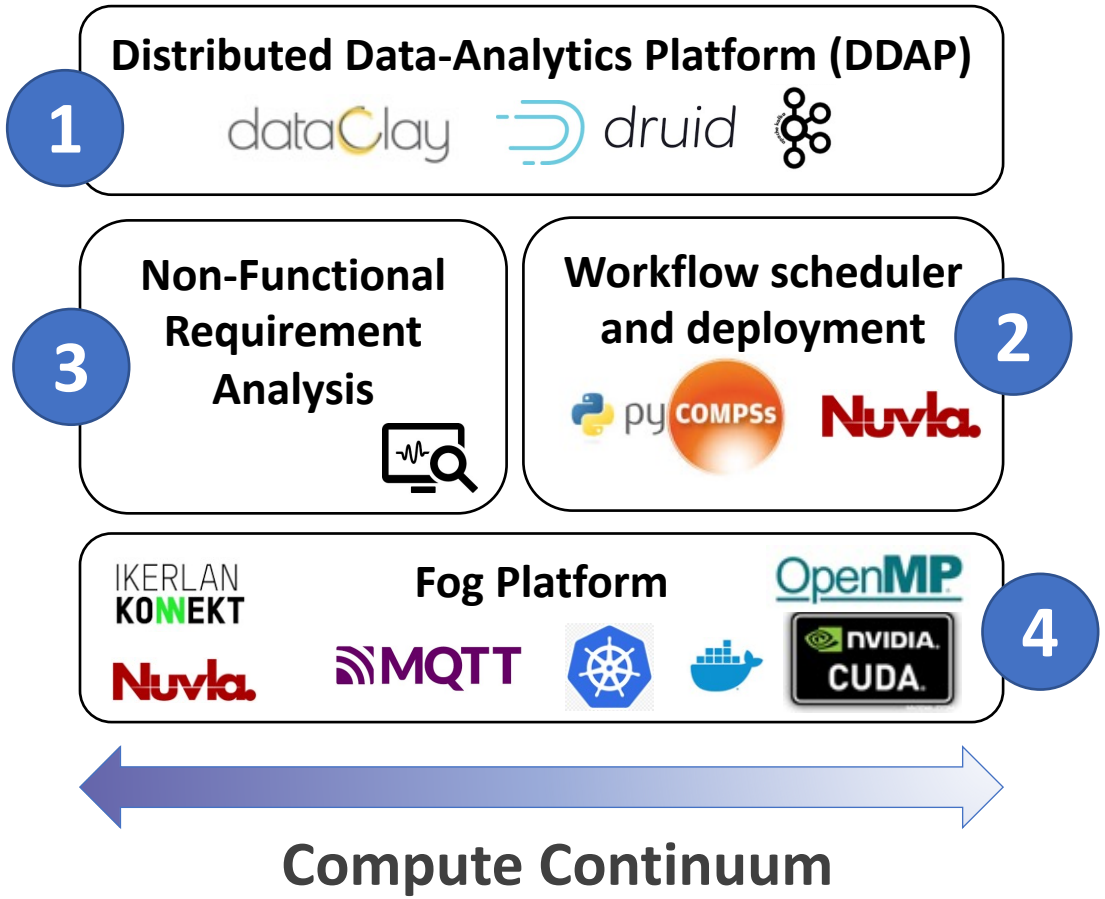
The Vision of ELASTIC



1. Significantly **increase the capabilities** of the data analytics by distributing them across the compute continuum
   - Integrate both responsive data-in-motion and latent data-at-rest analytics in a **single complex workflow**
2. **Fulfill** the non-functional properties inherit from the domain
3. Use **advance parallel and energy-efficiency embedded** platforms at edge side

Productivity + **Programmability** + **Portability/Scalability** + **Performance**

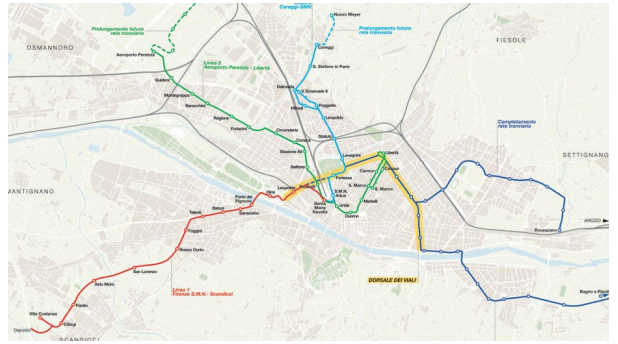
Main Contribution:
The ELASTIC Software Architecture



1. Powerful API for the development of advanced **data-analytics workflows**, supported with a **Distributed Data platform (DDAP)**
2. **Advanced orchestration methods** workflow scheduling and deployment
3. **Non-functional analysis** inherited from the cyber-physical domain
4. Fog-based platforms including
   - **Cloud-based** Container as a Service (Caas)
   - **IoT** cyber-secured communication
   - Advanced highly parallel and energy-efficiency **edge** platforms

Smart Mobility Use-Case

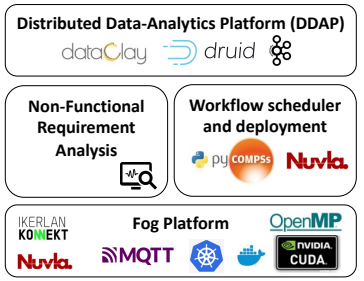
- Deployed on the Florence tramway network for testing the benefits of ELASTIC
  - Tram vehicles and infrastructure equipped with
    - Advanced parallel edge processor platforms
    - V2X communication
    - Variety of sensors (cameras, radars/LIDAR, IMU)
- Three smart mobility applications
  1. Next Generation Autonomous Positioning (NGAP) and Advanced Driving Assistant System (ADAS)
  2. Predictive maintenance
  3. Interaction between the public and the private transport in the City of Florence

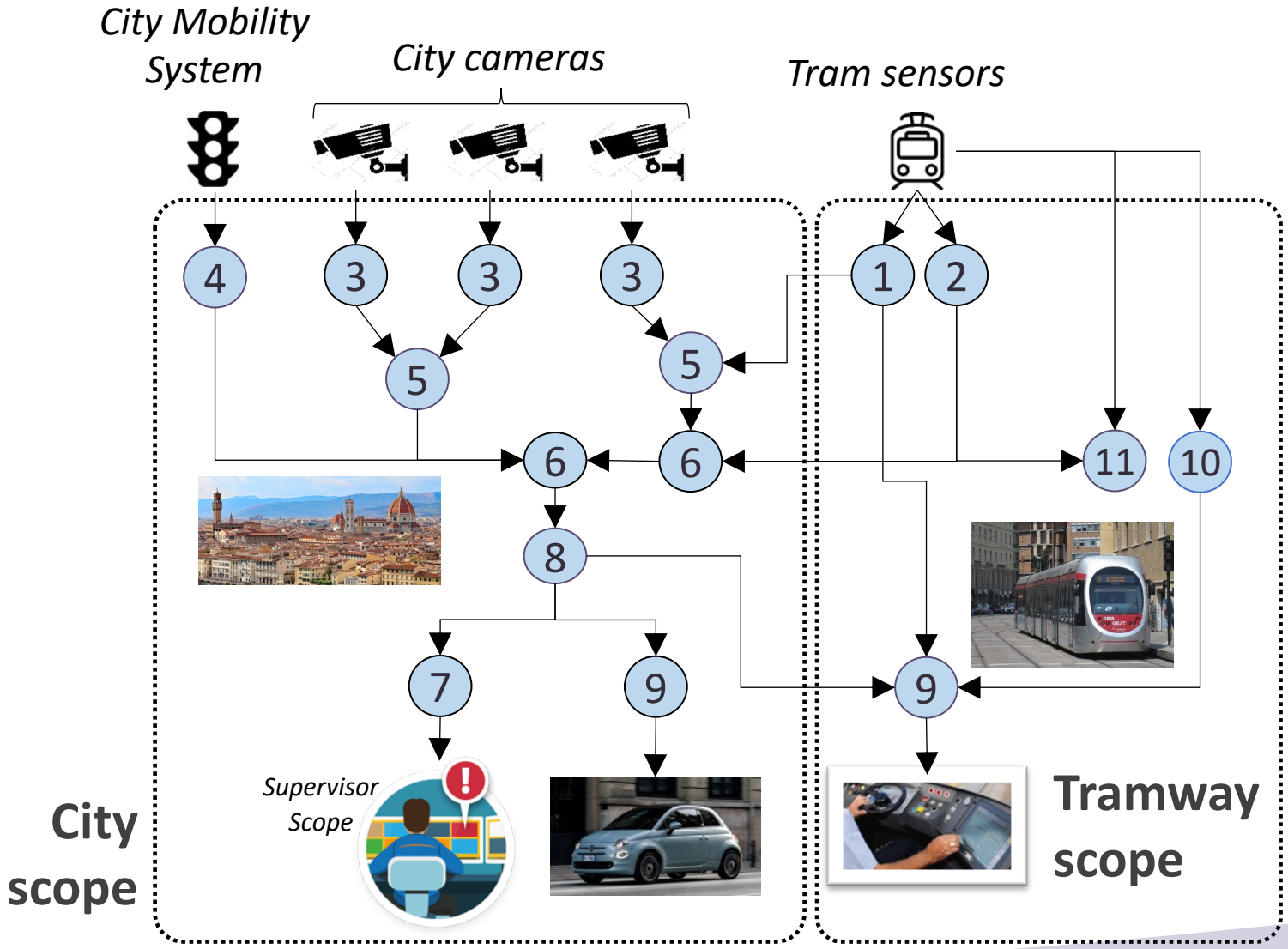


Smart Mobility Use-Case: Data-Analytics Workflow

Data Analytics Methods

1. Sensor fusion
2. Tram position
3. Object recognition
4. UTC/Supervisor consolidation
5. Data fusion
6. Data aggregation
7. Dashboard
8. Hazard detection
9. Alert visualization (cars/trams)
10. Electric power consumption
11. Defect Detector





Smart Mobility Use-Case: Compute Continuum

edge computers

camera

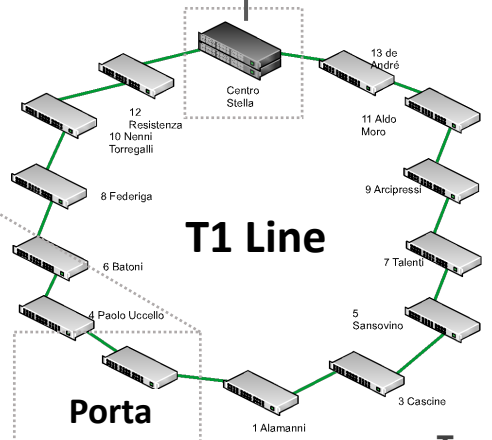
NGAP

LTE

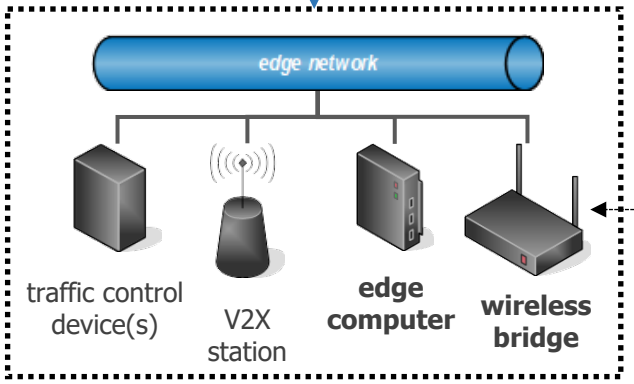
Wifi

Wifi

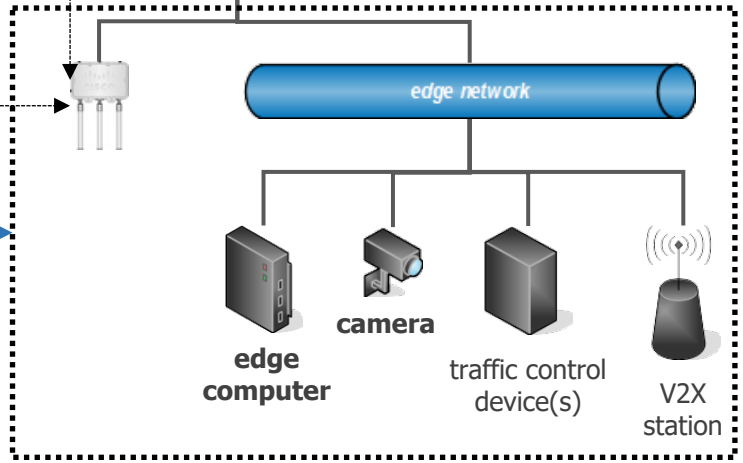
Cloud
(GEST depot)



Track cabinet (at stops)



Field cabinet (e.g. pole / semaphore / other)



Distributed Data-Analytics Platform (DDAP)

dataClay druid

Non-Functional Requirement Analysis

Workflow scheduler and deployment

pycompss Nuvla

Fog Platform

IKERLAN KONEKT Nuvla MQTT OpenMP NVIDIA CUDA

Conclusions

1. ELASTIC aims to develop a novel **software architecture** with the following capabilities:
   - Increase data analytics capabilities by efficiently combine data-in-motion and data-at-rest analytics into **complex workflows**
   - Increase the development and deployment **productivity** of systems requiring data-analytics
   - Guarantee the non-functional requirements inherited from the domain
2. ELASTIC is applying the software architecture to develop a distributed sensing/computing infrastructure within the Florence tramway network for advanced urban mobility applications

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Stay Tuned!

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