



A Software Architecture for Extreme-Scale  
Big-Data Analytics in Fog Computing Ecosystems

# Assessing the Infrastructure and Technologies Required to Implement Smart Mobility



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- H2020 ICT European Project
  - ELASTIC: a software architecture for Extreme-scaLe big-data AnalyticS in fog compuTing eCosystems
- [www.elastic-project.eu](http://www.elastic-project.eu)



## Project Information

### ELASTIC

Grant agreement ID: 825473



#### Start date

1 December 2018

#### End date

31 May 2022

#### Funded under

H2020-EU.2.1.1.

#### Overall budget

€ 5 920 581,25

#### EU contribution

€ 5 920 581,25



#### Coordinated by

BARCELONA SUPERCOMPUTING CENTER-  
CENTRO NACIONAL DE SUPERCOMPUTACION



## From Data to Real-time Knowledge

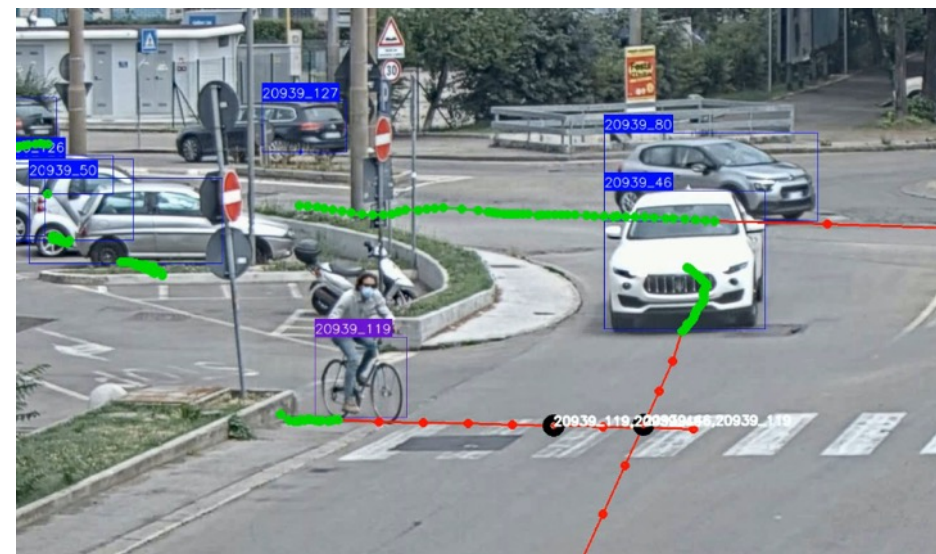
Data



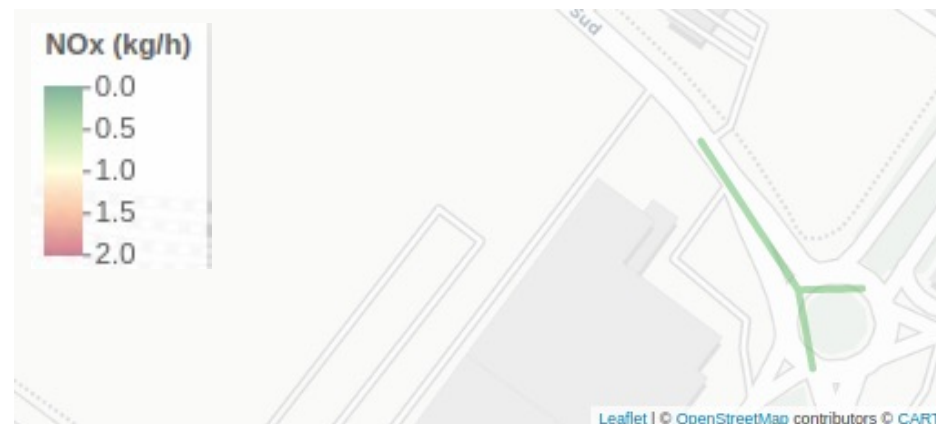
Knowledge



*Collision  
Detection*

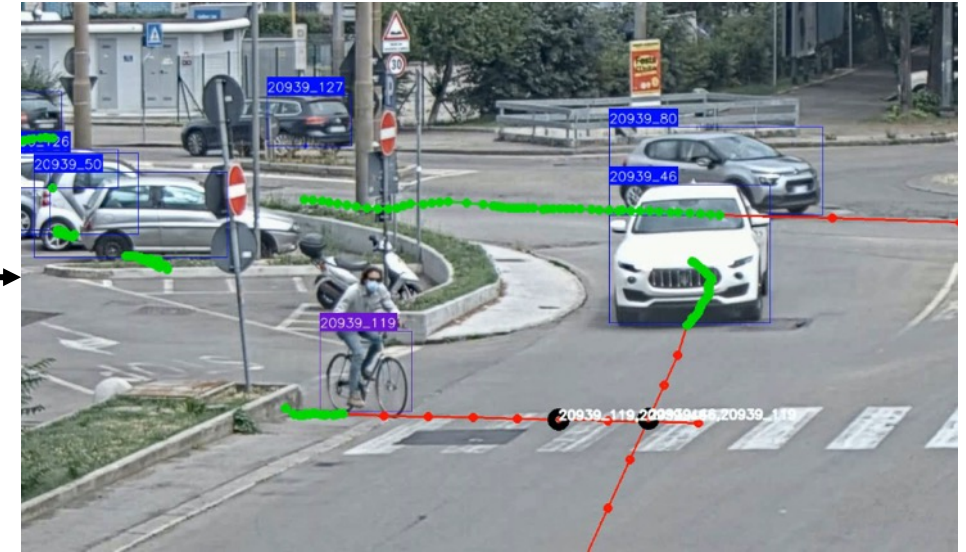


*Air  
Pollution  
Estimation*

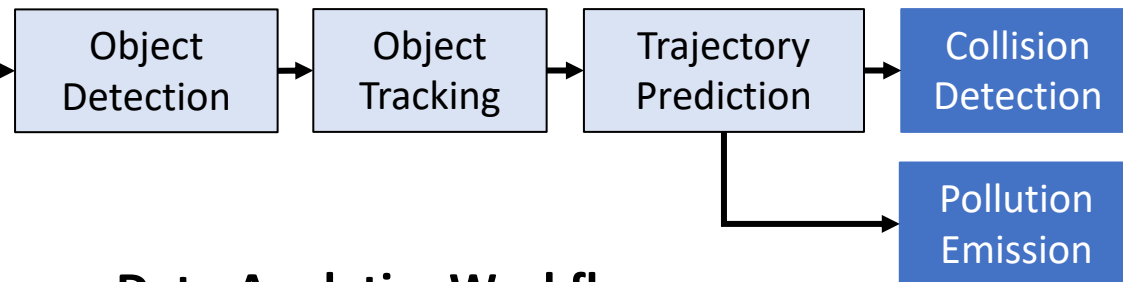




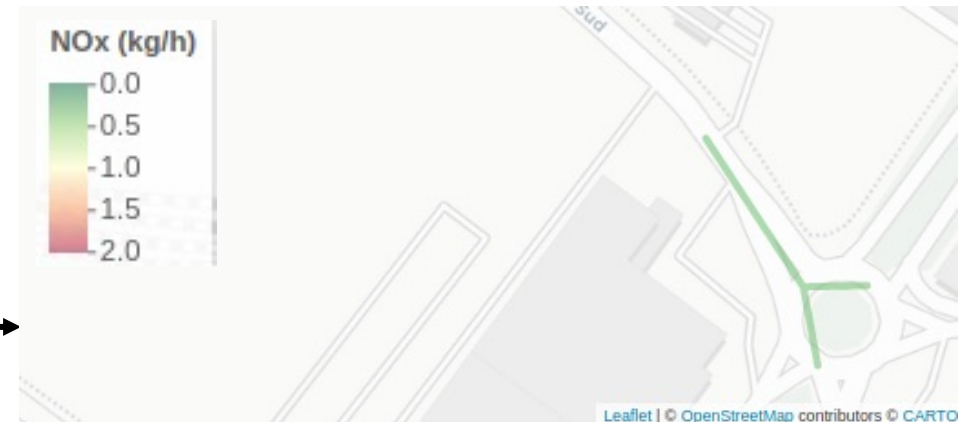
Data  Knowledge



*End-to-end response time*

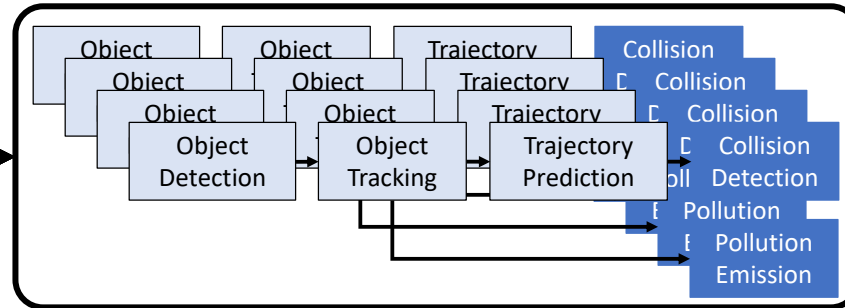


**Data-Analytics Workflow**





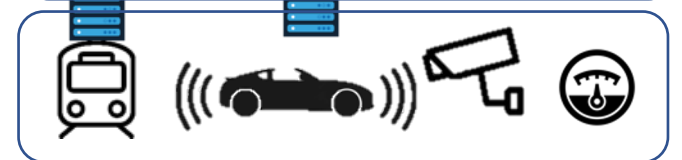
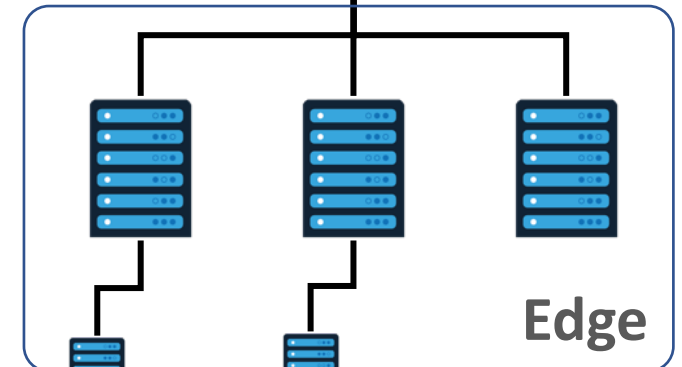
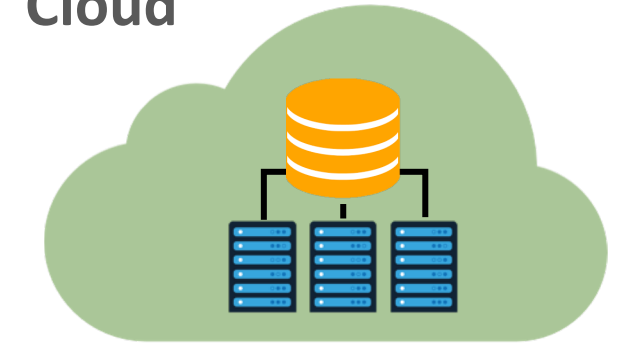
## From Data to Real-time Knowledge



How are the data-analytics workflows developed and mapped to the available **computing/communication resources**?

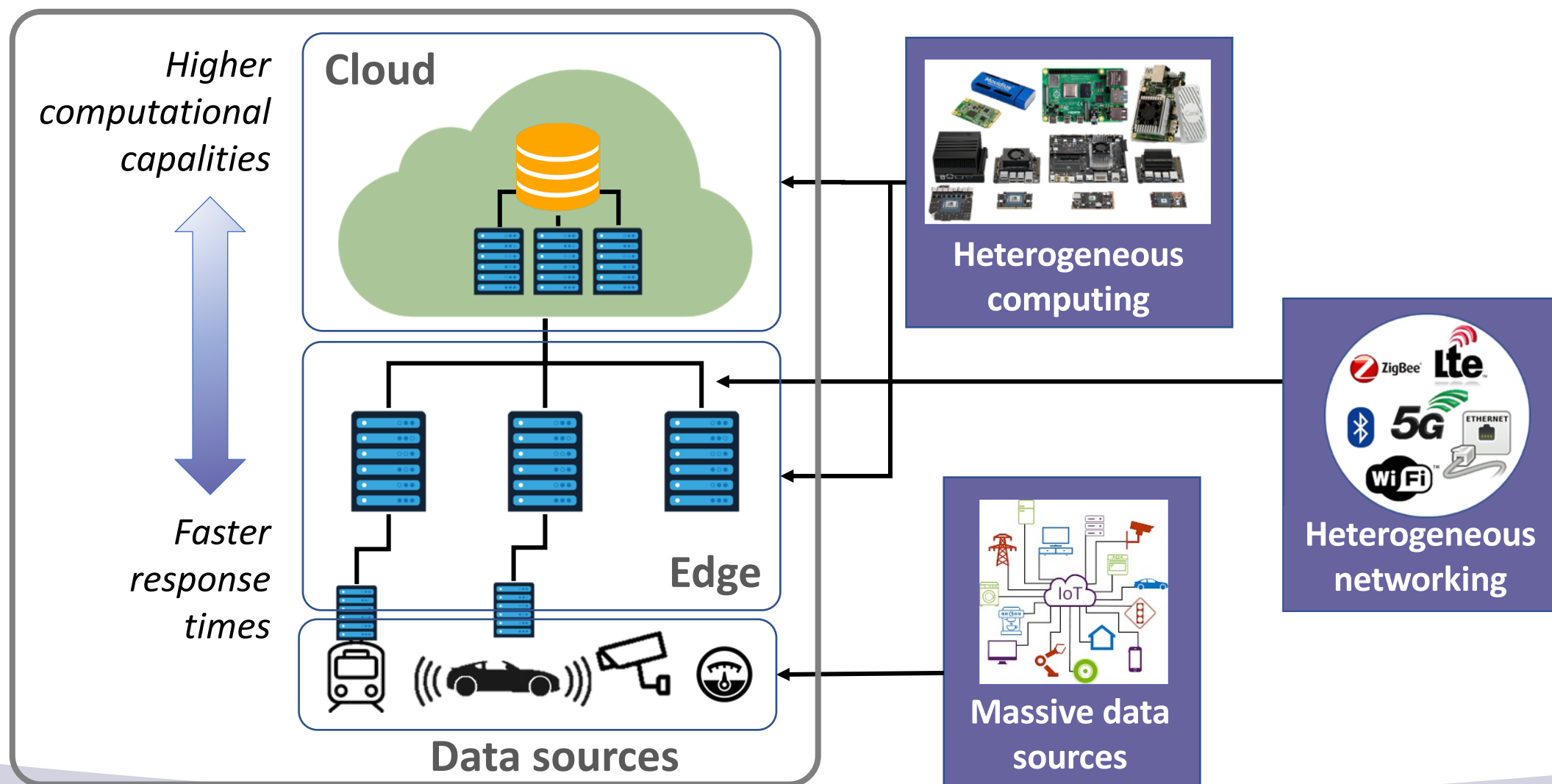
Computing/Communication  
City Resources

Cloud

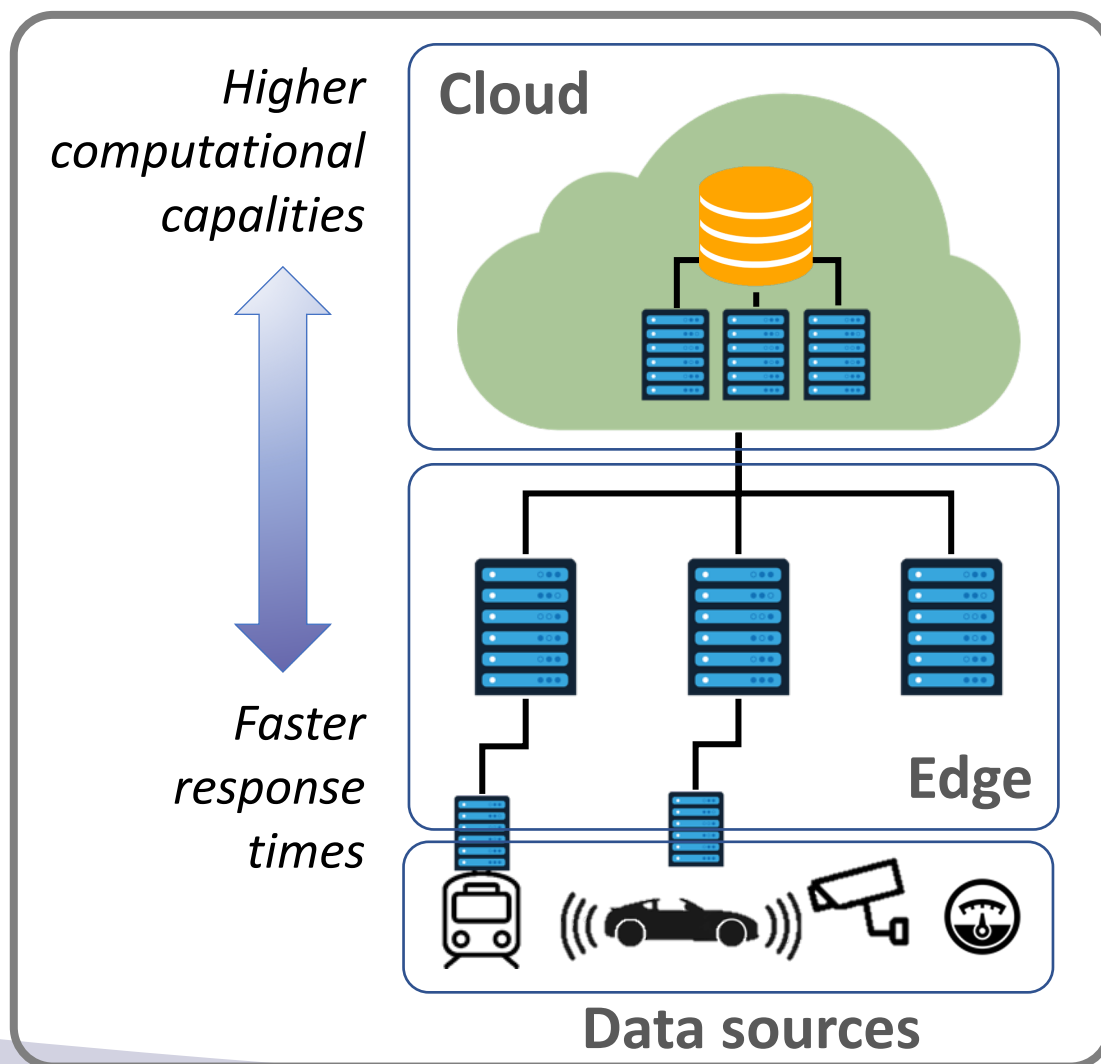


Data sources

# ELASTIC Vision: The Compute Continuum



## Compute Continuum

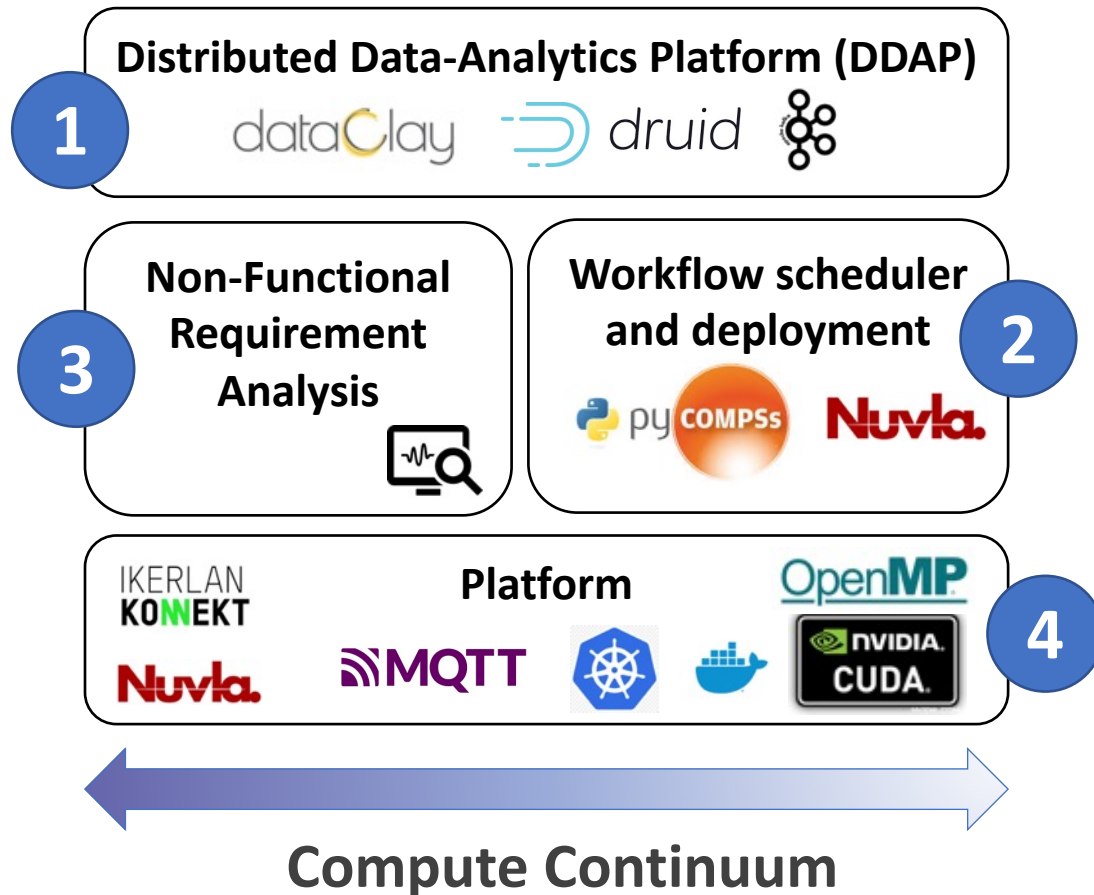


## ELASTIC Vision: The Compute Continuum

1. Facilitate the development of **complex data analytics workflows** independently of the platform
2. Increase the **capabilities of the data analytics** by distributing them across the compute continuum
3. Fulfill the **non-functional requirements** inherited from the application domain, e.g., real-time, privacy



# Main Contribution: The ELASTIC Software Architecture



## Abstracts the compute continuum

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. Infrastructure support
  - Cloud-based Container as a Service
  - IoT cyber-secured communication
  - Advanced highly parallel and energy-efficiency edge platforms

# ELASTIC Smart Mobility Use Case: the City of Florence Tramway Network



Towards  
autonomous  
vehicles



Towards smart and  
safer mobility



Towards enhanced  
maintenance  
services

THALES

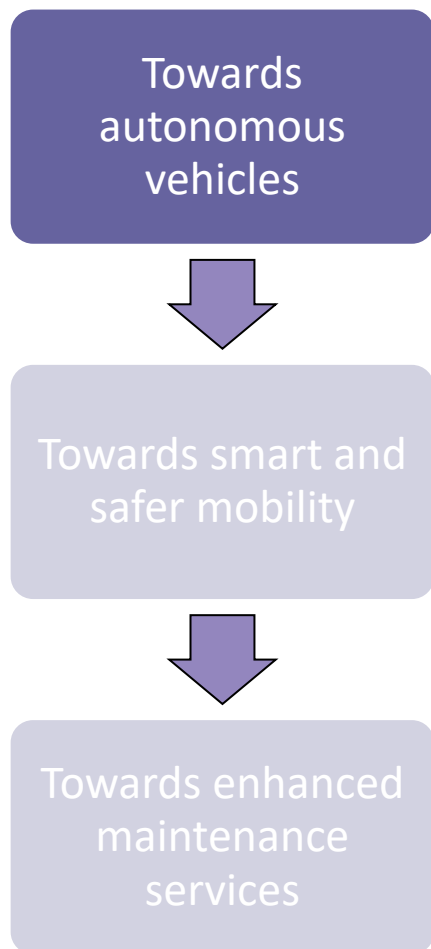


CITTÀ  
METROPOLITANA  
DI FIRENZE

GEST



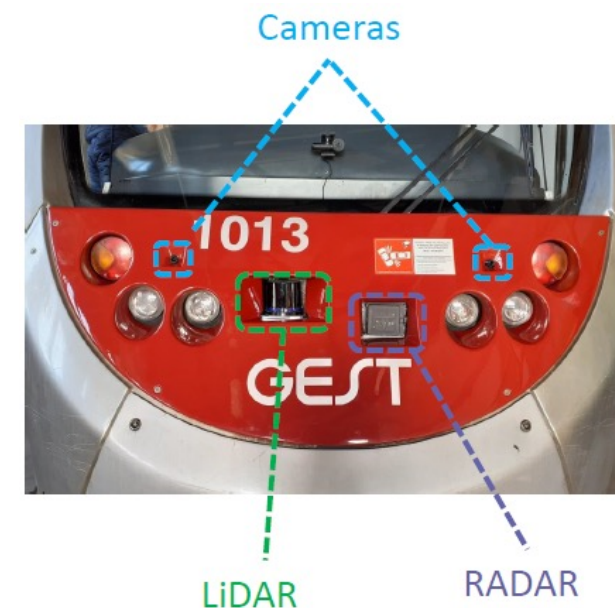
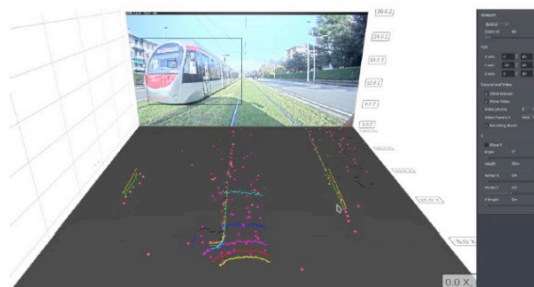
## ELASTIC Smart mobility use case: The Tramway Vehicle



- ✓ Next Generation Autonomous Positioning (NGAP)
- ✓ **Advanced Driving Assistant System (ADAS)**

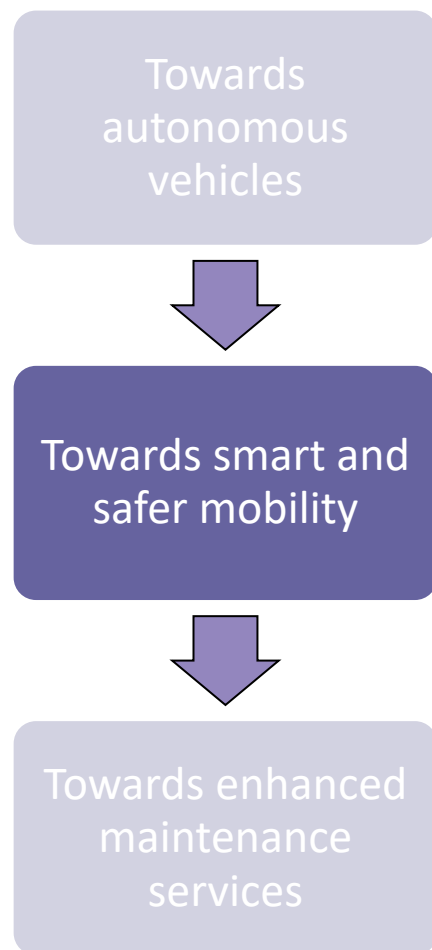
- Sensorized trams

- Inertial Measurement Unit (IMU)
  - Odometer
  - GPS
  - Lidar
  - Radar
  - Cameras

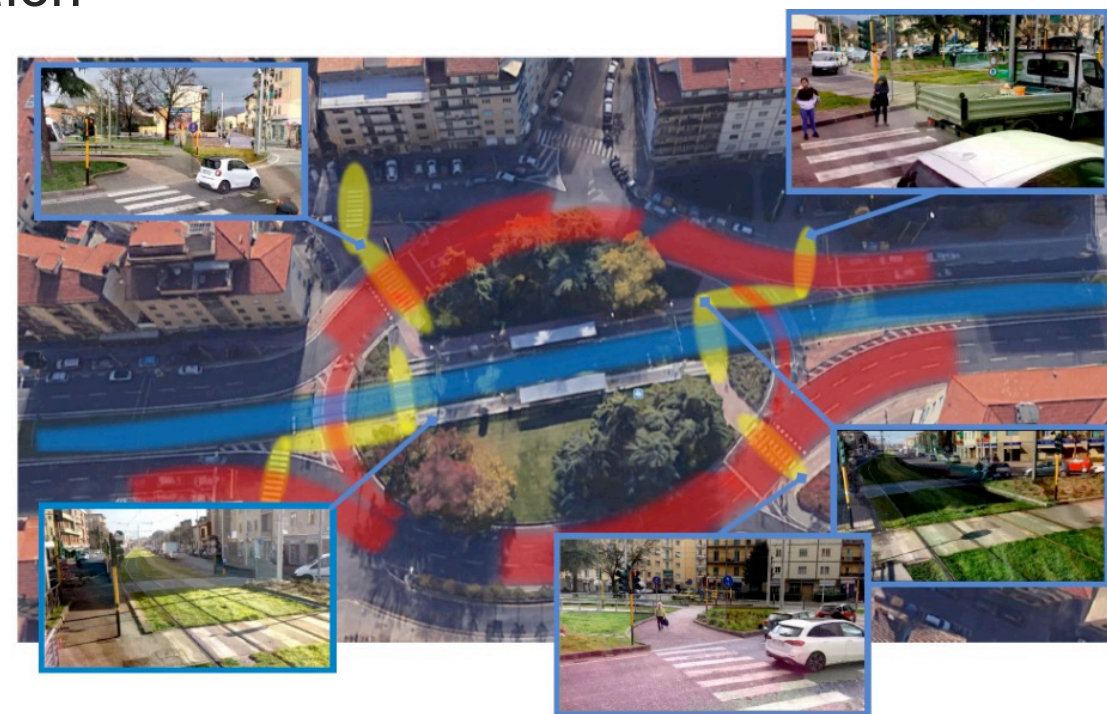


- Advanced parallel edge processor platforms
- WiFi and LTE connectivity

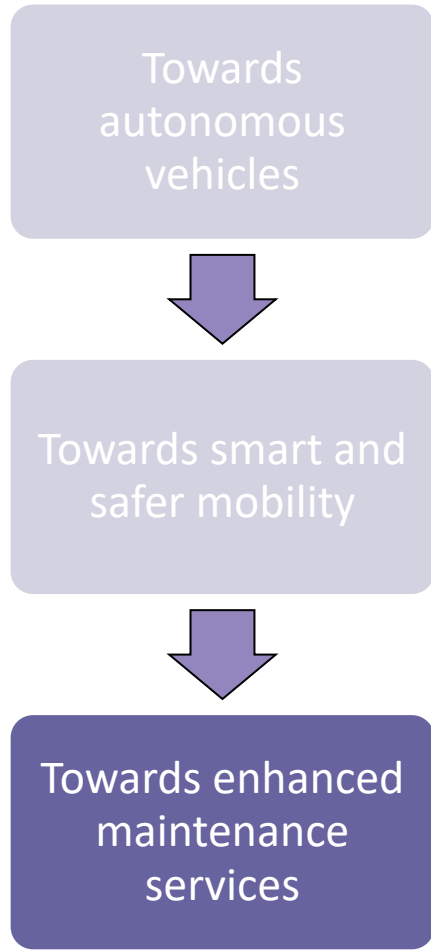




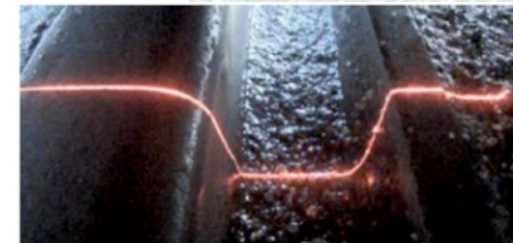
- ✓ Interaction between the public and the private transport in the City of Florence
  - Real-time event detection and hazard alerts
  - Offline analytics for traffic management and air pollution estimation
- Sensors
  - Cameras



# ELASTIC Smart mobility use case: The Tramway Infrastructure

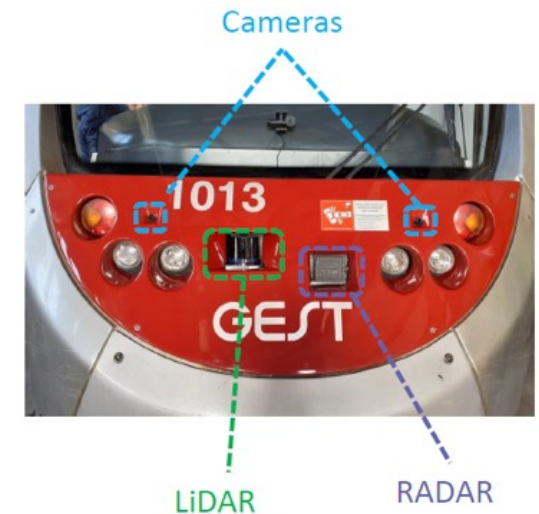


- ✓ Predictive maintenance
  - Track profiling and automatic detection of track wear
- Sensors employed
  - Energy extraction unit
  - Laser measuring heads
  - Accelerometers
  - Cameras
  - Odometers
  - Inertial platform



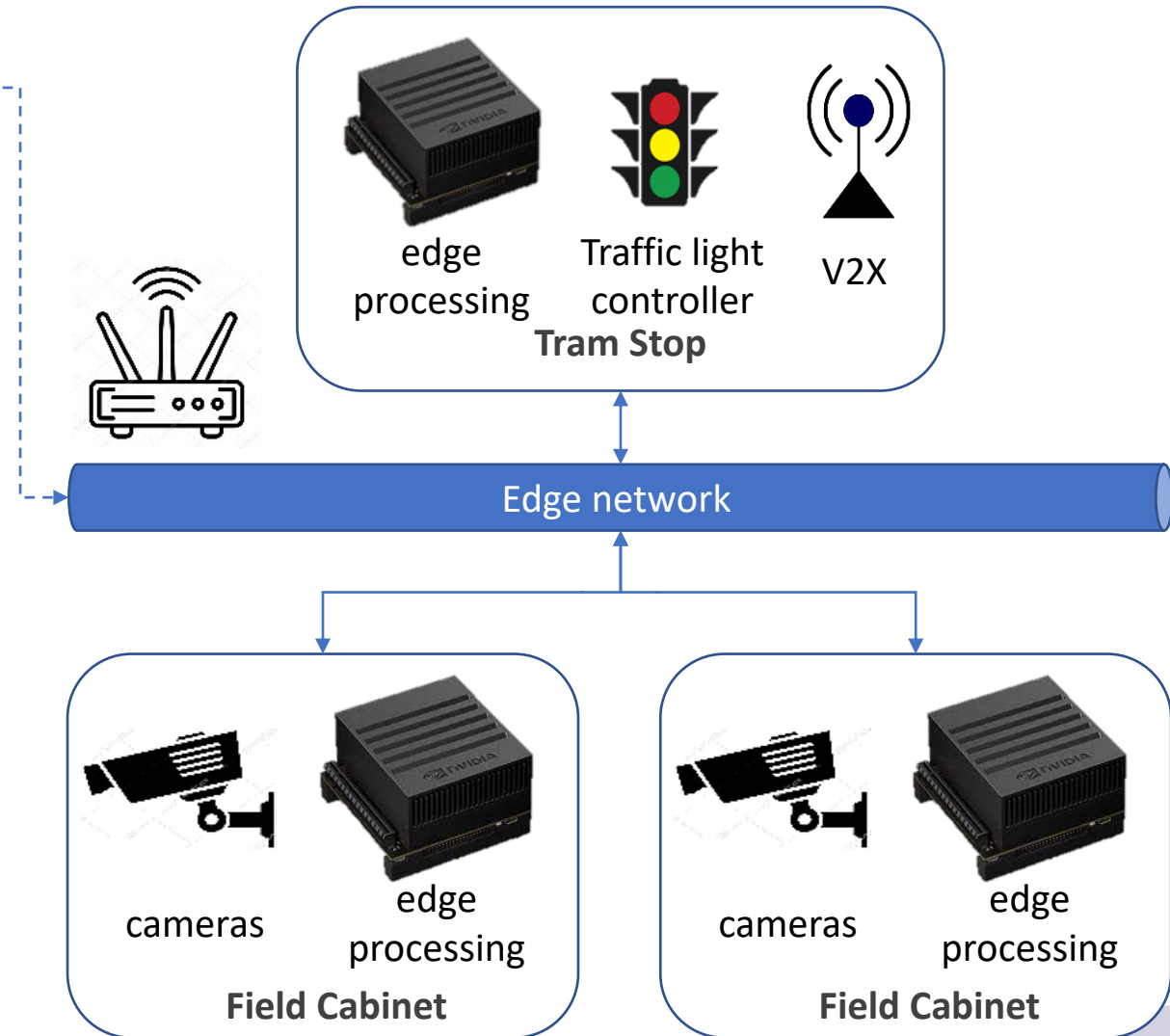
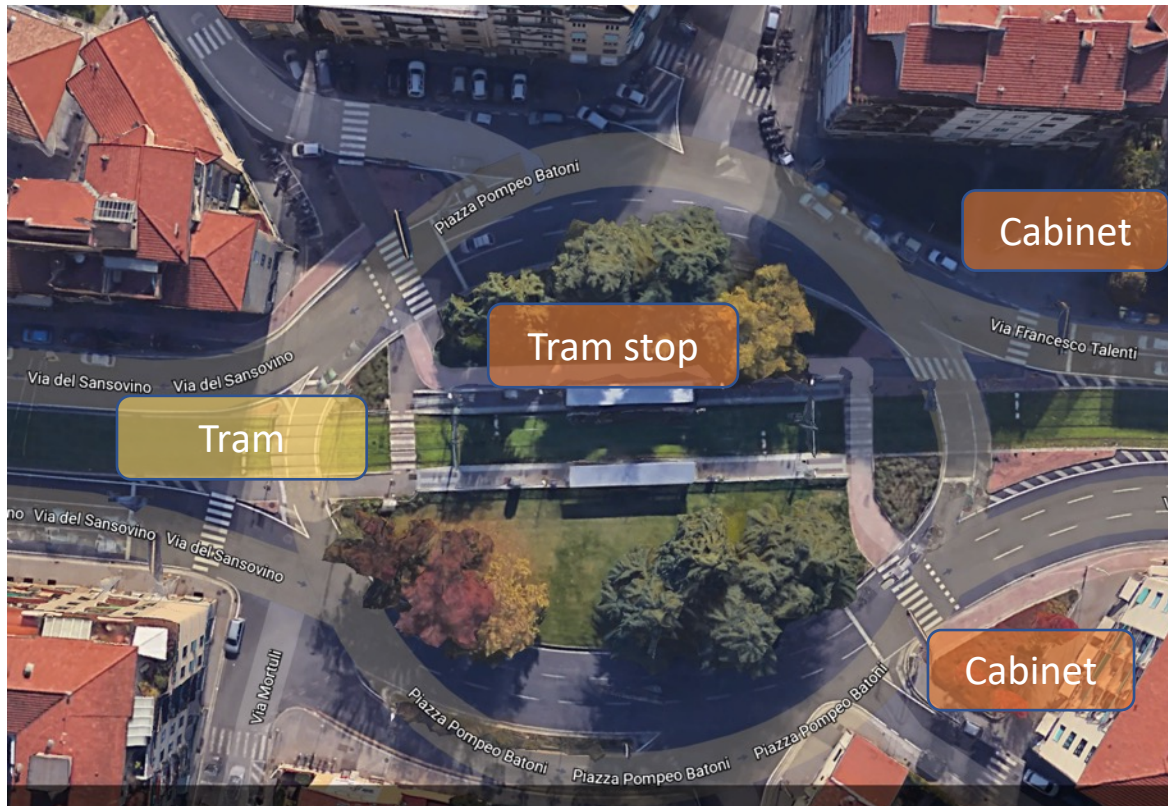
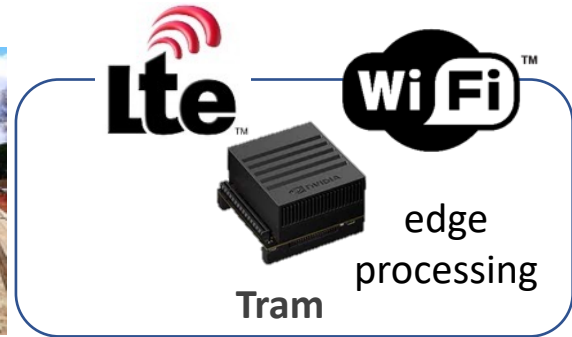


- Three tramway stops
- Three sensorized tram vehicles

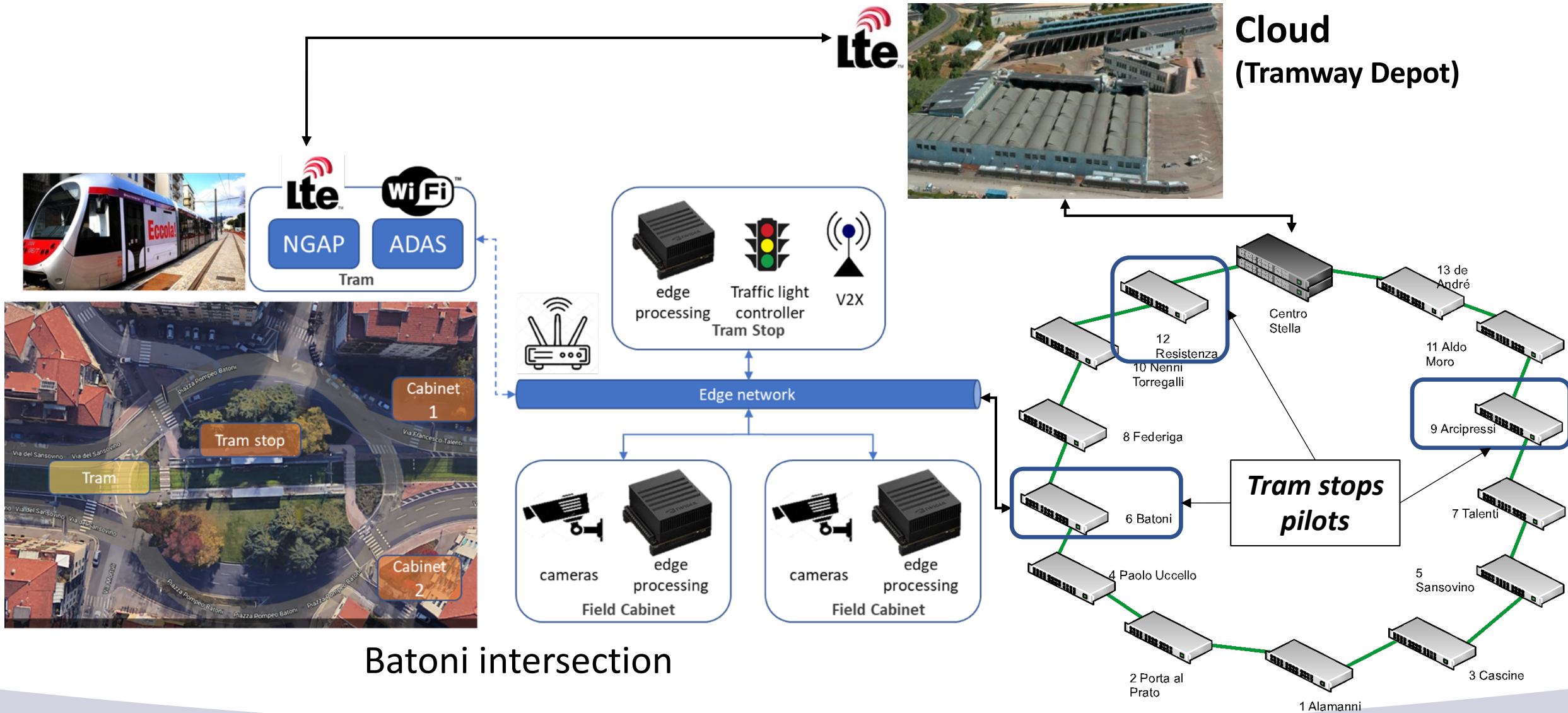




## The ELASTIC Compute Continuum: Tram Stops



# The ELASTIC Compute Continuum: the Cloud

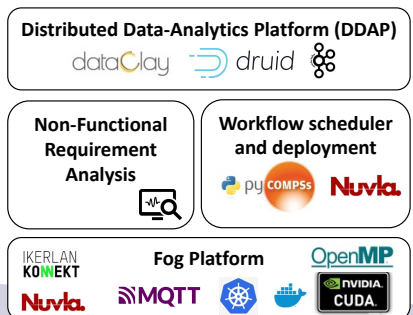
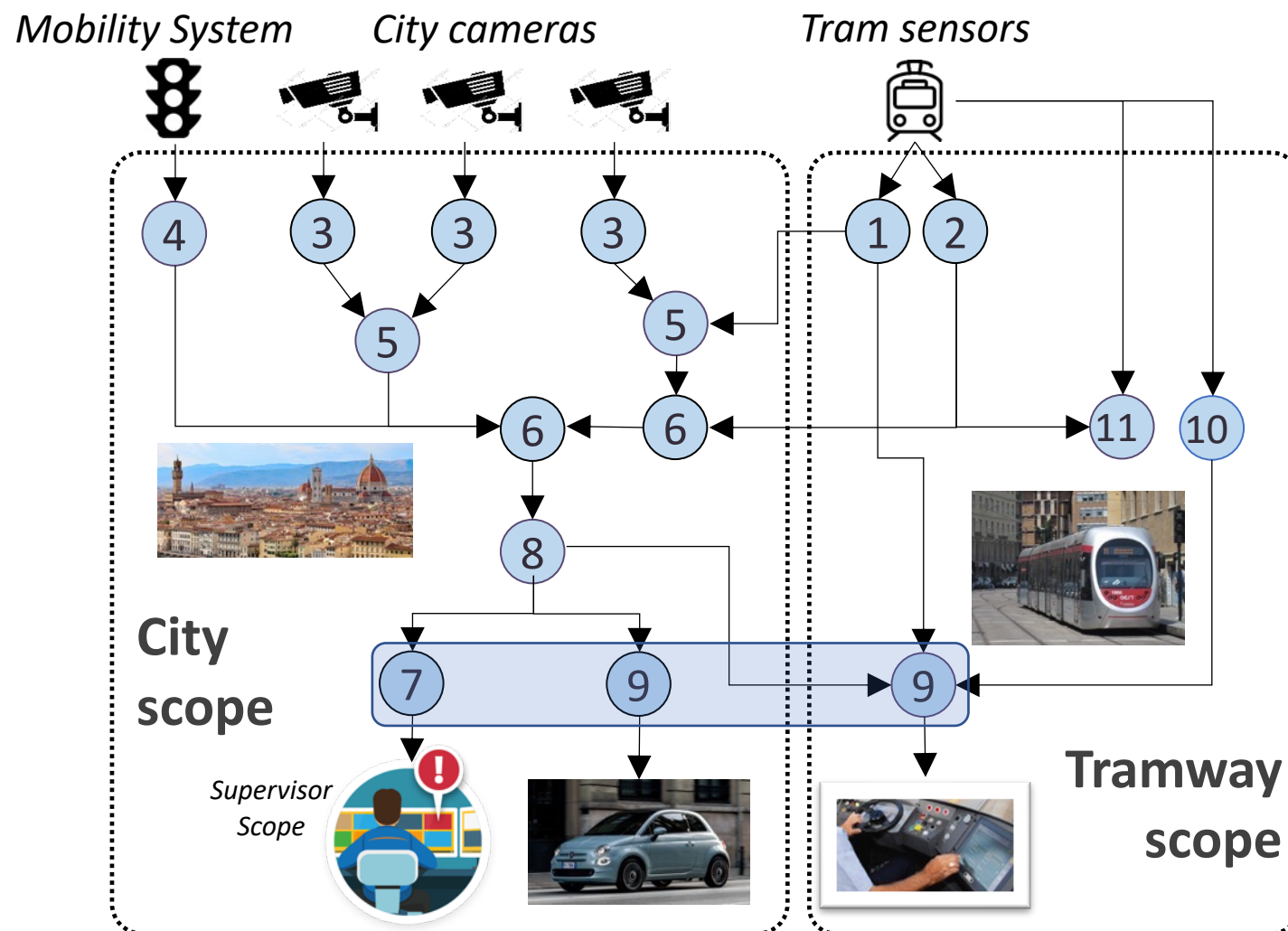




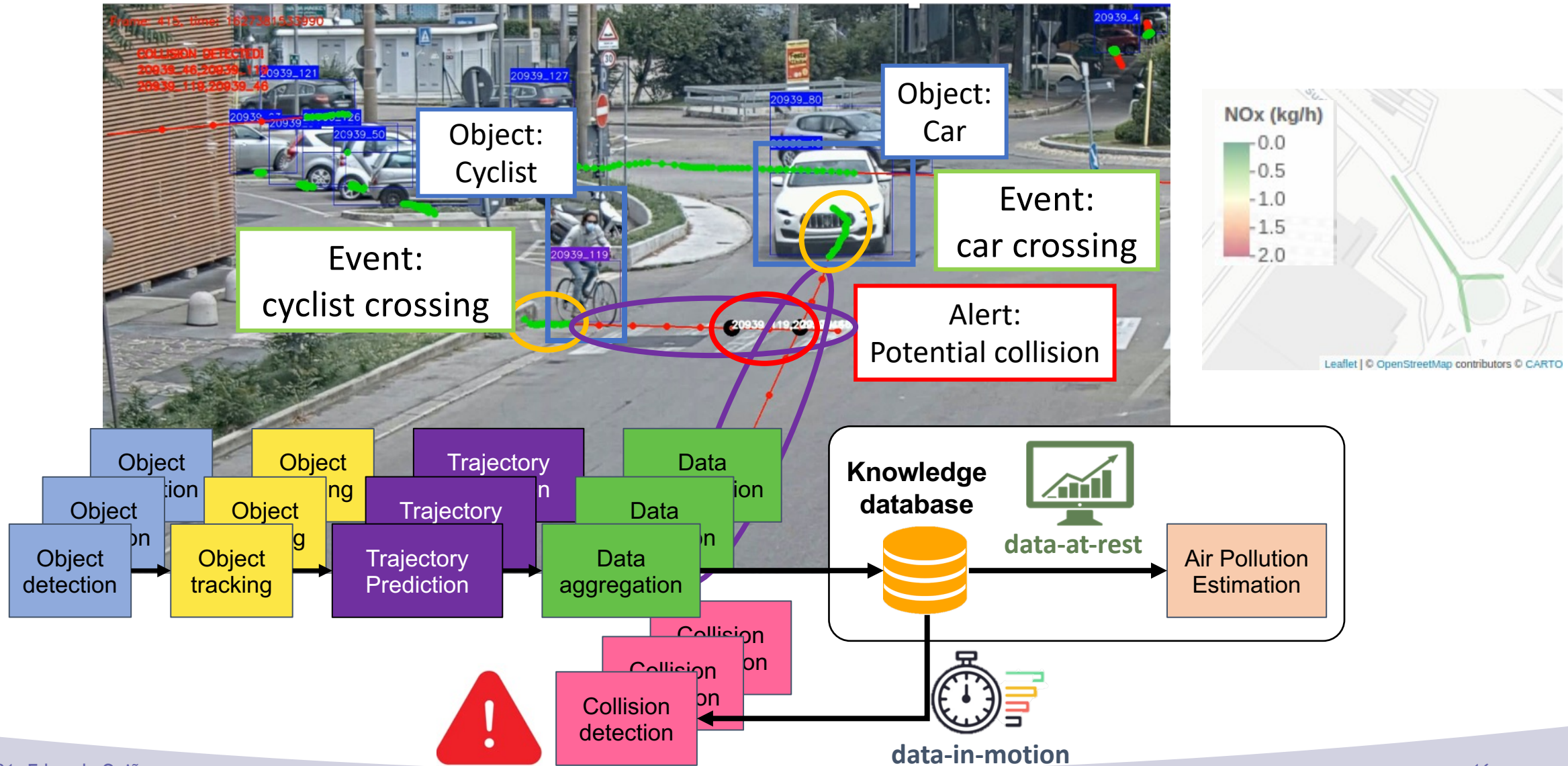
## The ELASTIC Data-Analytics Workflow

### Data Analytics Methods

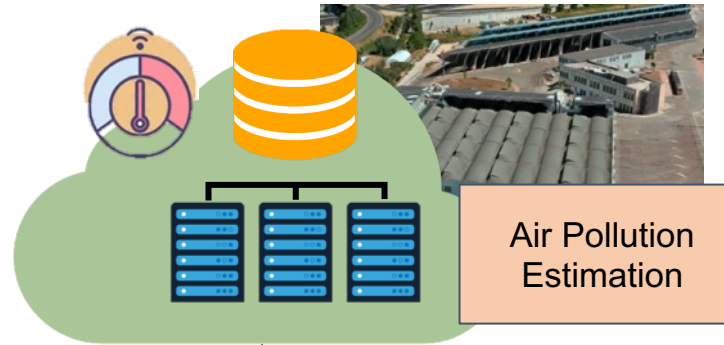
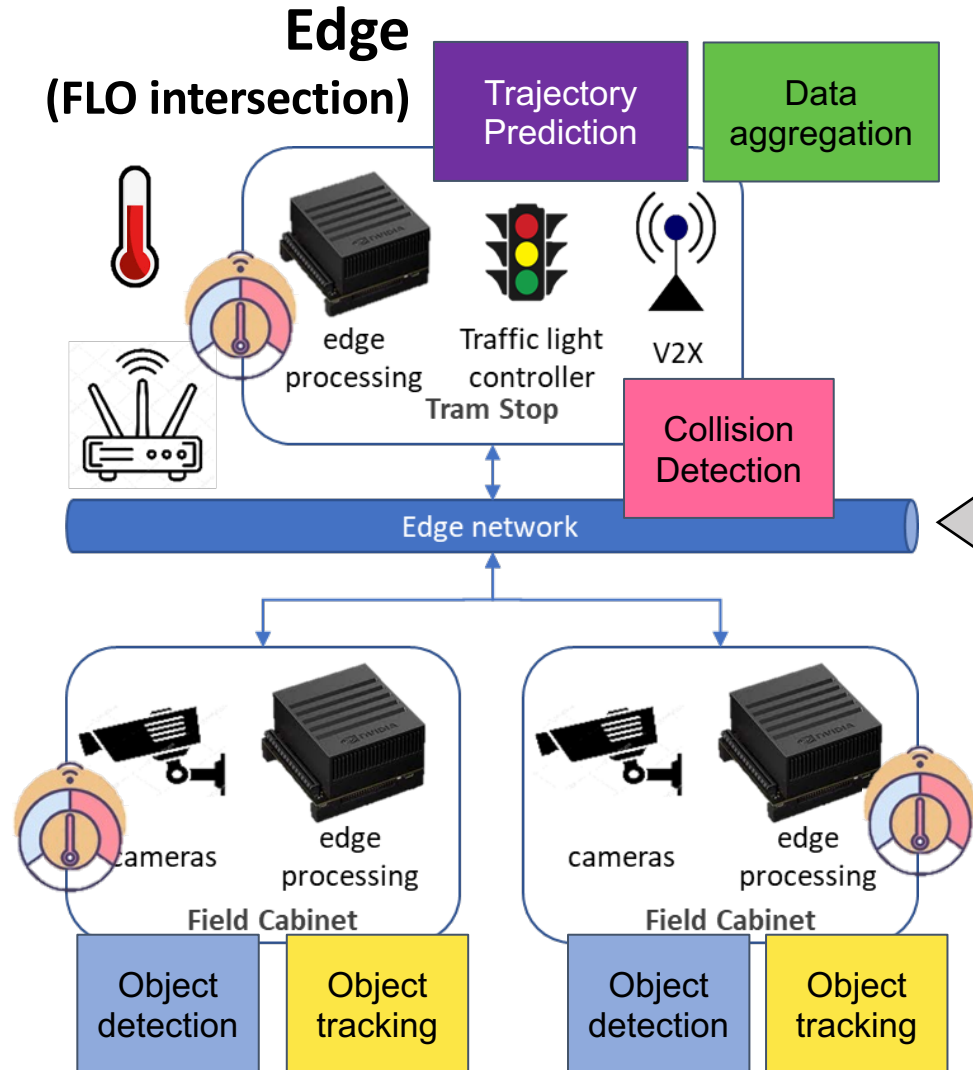
1. Sensor fusion (ADAS)
2. Tram position (NGAP)
3. Object detection
4. UTC/Supervisor consolidation
5. Data fusion
6. Data aggregation
10. Electric power consumption
11. Defect Detector
- 7. Dashboard**
- 8. Hazard detection**
- 9. Alert visualization (cars/trams)**



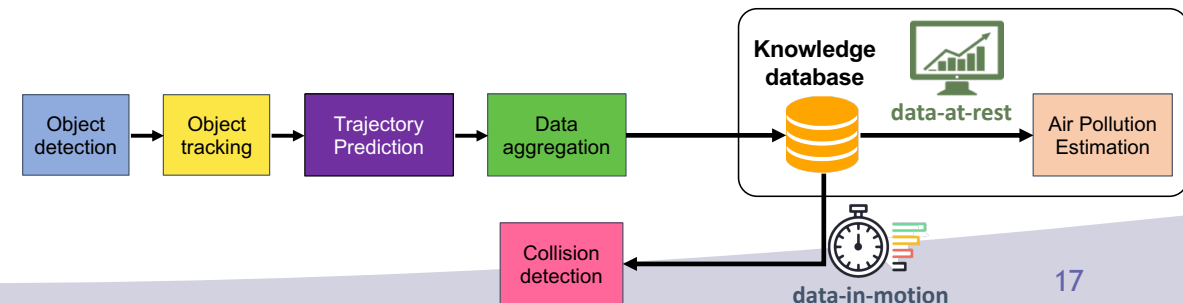




## Execution of Data-Analytics across the Compute Continuum

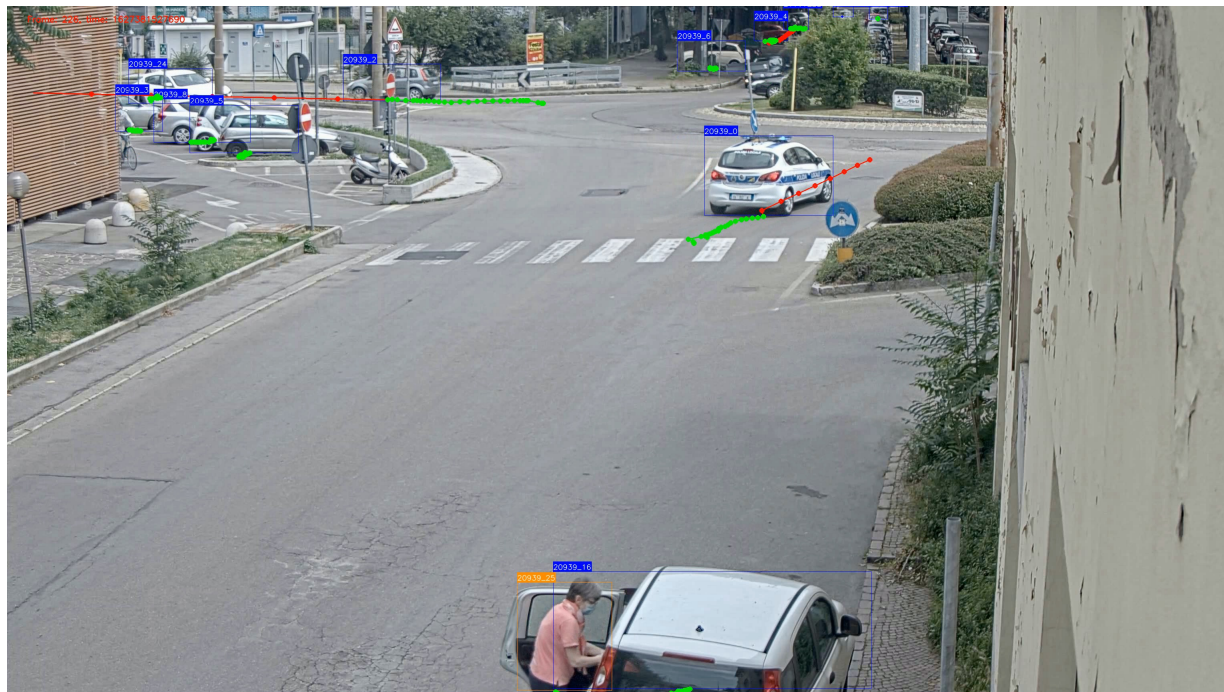


1. Automated **deployment** and **scheduling** of data-analytics
2. Constant **monitoring** of execution
3. **Re-scheduling** on-the-fly if a requirement is violated





# Execution of Data-Analytics across the Compute Continuum







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# Stay Tuned!

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