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Ευρωπαϊκό Ταμείο Περιφερειακής Ανάπτυξης
ΕΥΡΩΠΑΪΚΗ ΕΝΩΣΗ
step2smart

Διασυνοριακή Συνεργασία Νησιώτικων Αστικών Περιοχών για Βελτίωση των Περιβαλλοντικών Συνθηκών μέσω Χρήσης Συστημάτων Ευφυών Μεταφορών

Συγχρηματοδοτείται από την Ευρωπαϊκή Ένωση (Ε.Τ.Π.Α.) και από Εθνικούς πόρους της Ελλάδας και της Κύπρου

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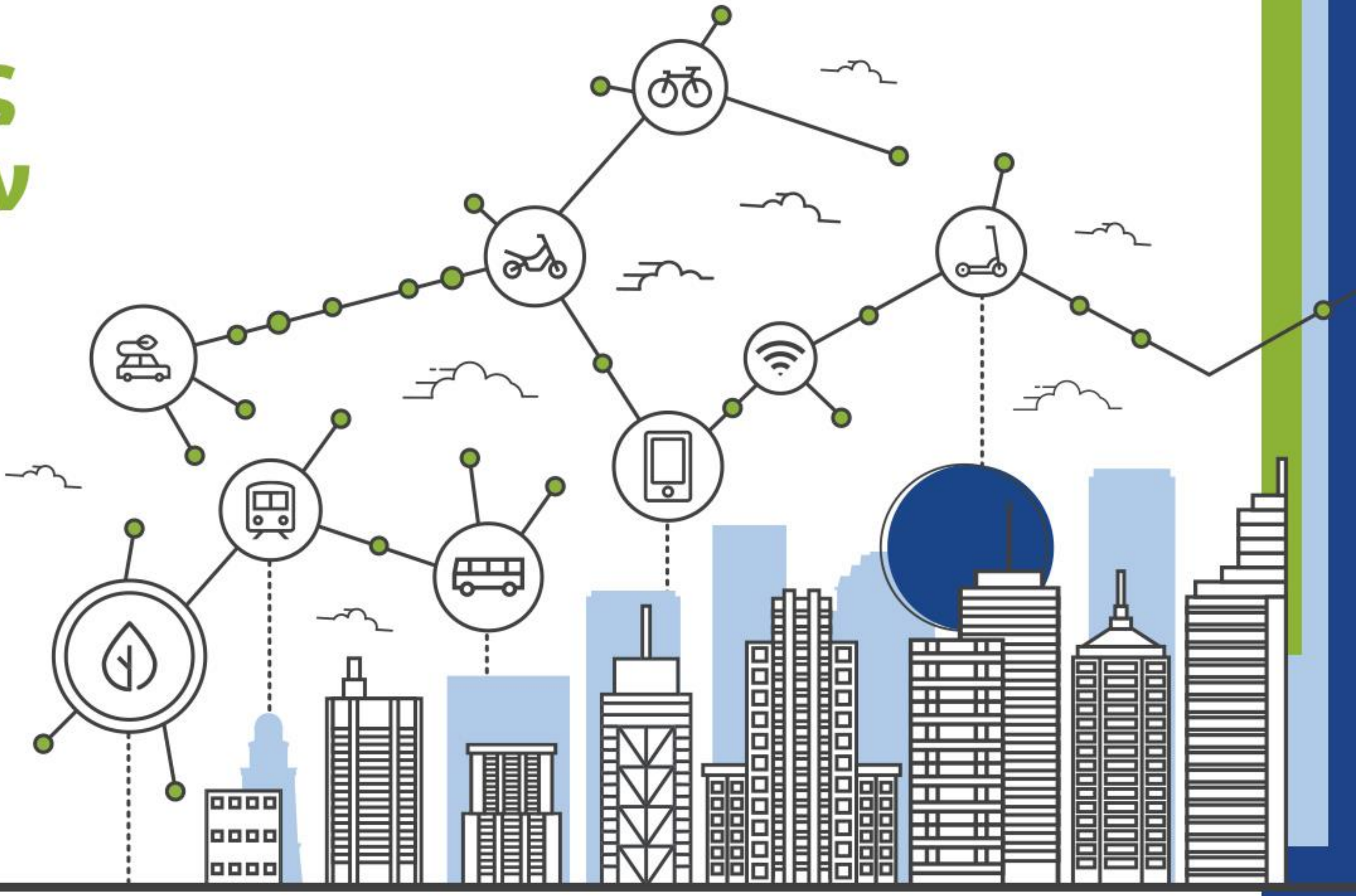
7ο Συνέδριο
Βιώσιμης Κινητικότητας και Ευφυών Συστημάτων Μεταφορών



ΚΥΠΡΙΑΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΥΠΟΥΡΓΕΙΟ ΜΕΤΑΦΟΡΩΝ, ΕΠΙΚΟΙΝΩΝΙΩΝ ΚΑΙ ΕΡΓΩΝ

ΤΜΗΜΑ ΔΗΜΟΣΙΩΝ ΕΡΓΩΝ

ΚΛΑΔΟΣ ΒΙΩΣΙΜΗΣ ΚΙΝΗΤΙΚΟΤΗΤΑΣ

Integrated Roadway Condition Assessment and Traffic Monitoring

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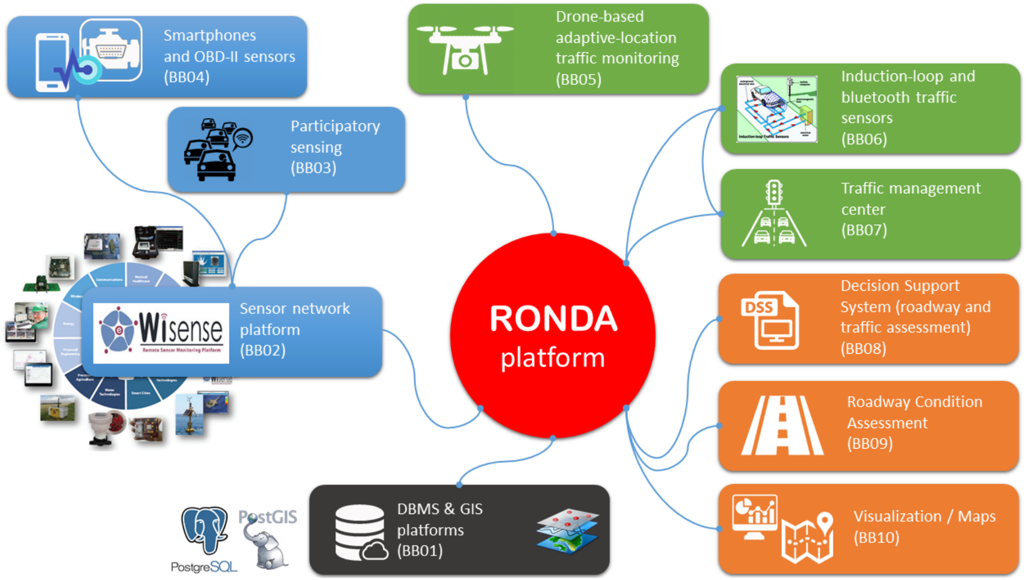
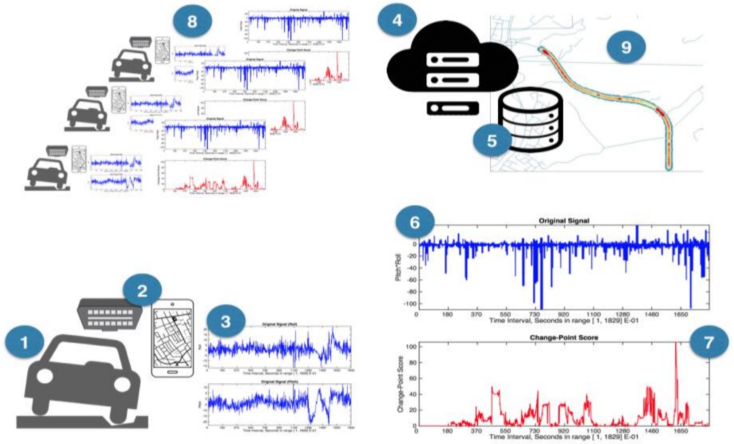
Integrated Roadway Condition Assessment and Traffic Monitoring

Key Objectives

- Development of **low-cost** technologies for
  - traffic monitoring & management,
  - roadway pavement condition assessment
- Integration with and utilization of other national initiatives
  - ‘Smart City’, ‘Digital Twin’, ‘National Single Access Point’, ‘DIAVLOS’, digital transformation, etc.

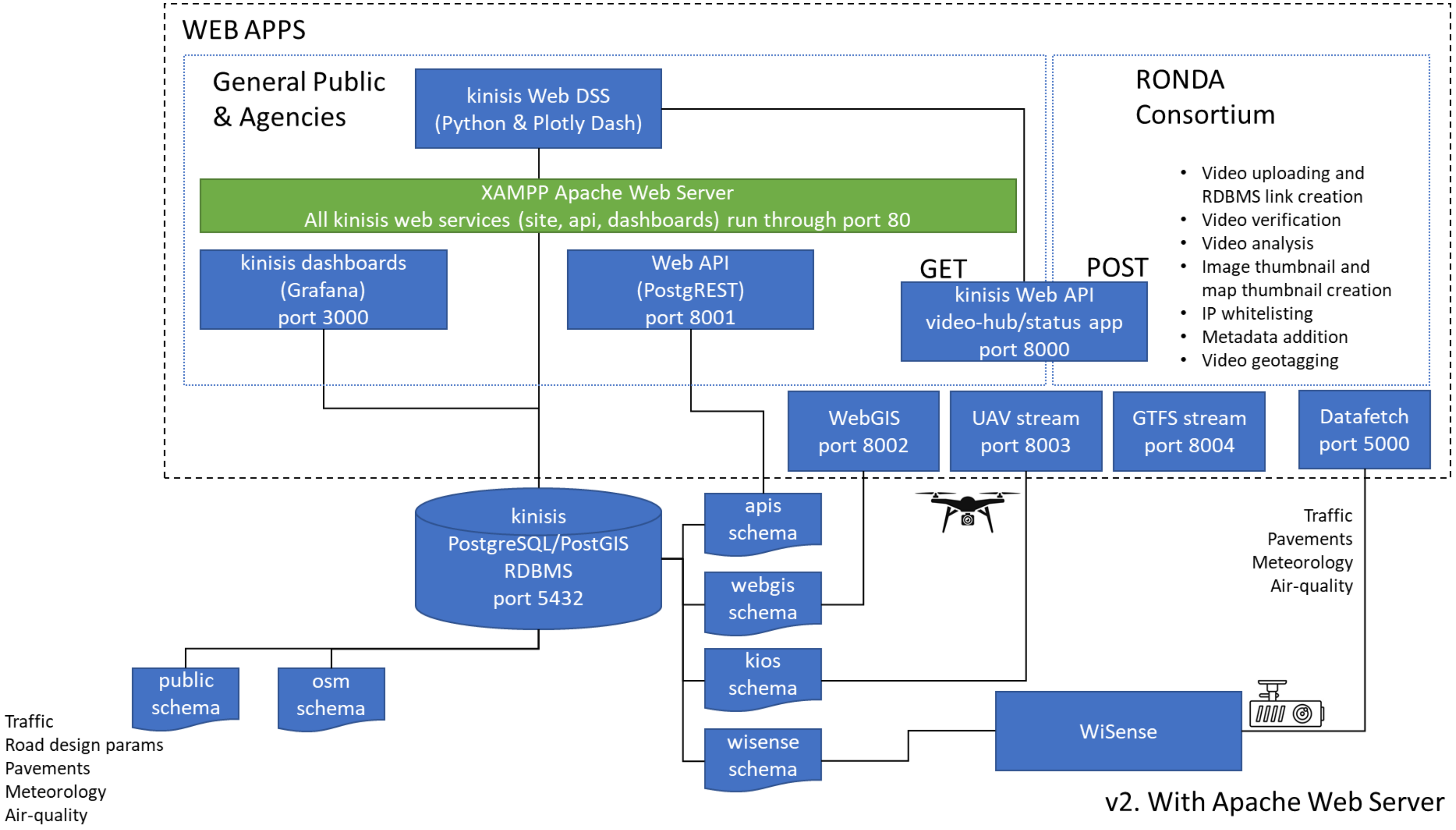




System Platform Architecture

Key Characteristics

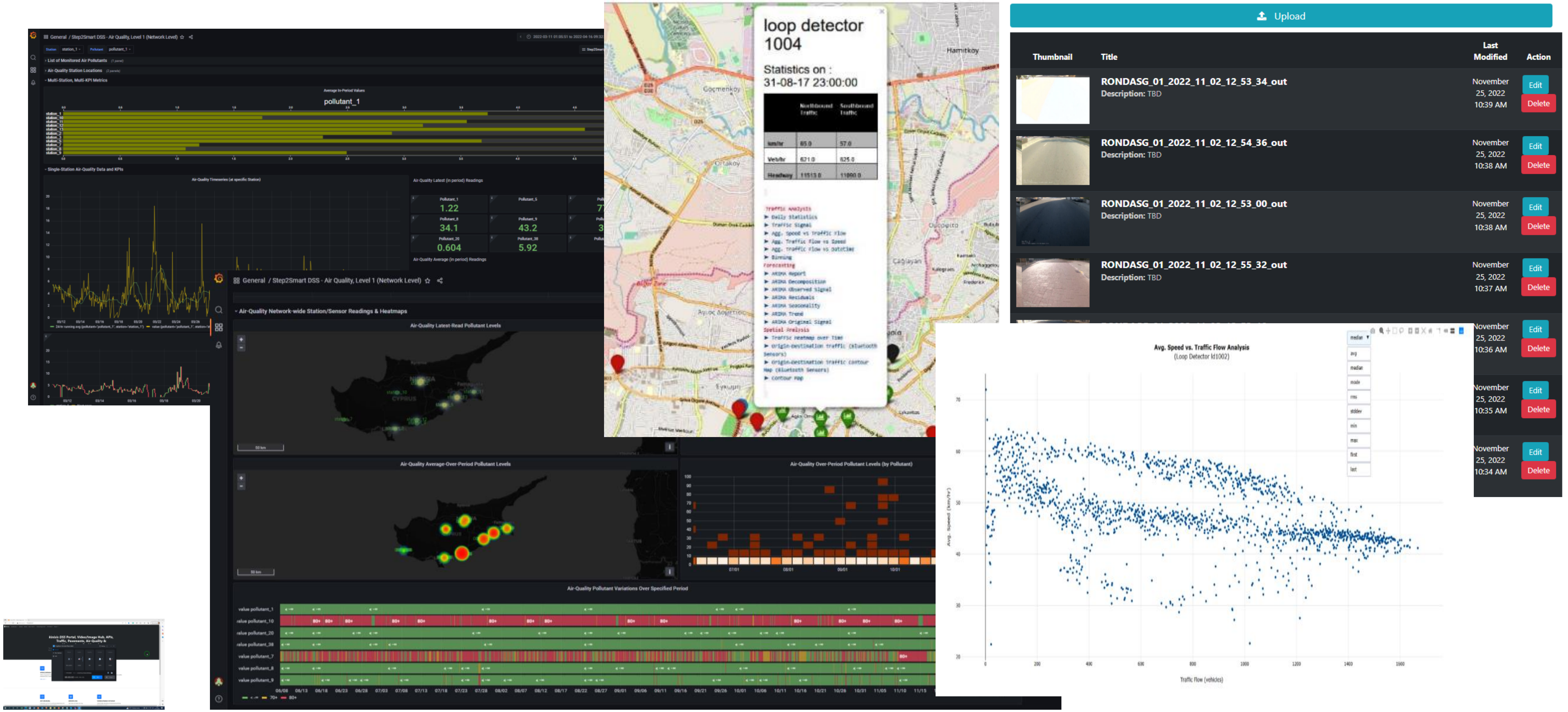
- Web/Cloud based
- webGIS and webDSS
- Automation through
  - participatory sensing,
  - machine-learning,
  - machine-vision,
  - decision support systems
- User/Agency-based security and access
- Modular & Scalable
- Open-Source software
- Integration of multiple data-sources
  - terrestrial and aerial traffic monitoring, roadway pavements, air-quality, meteorology, bus service, etc.
- Multitude of APIs



v2. With Apache Web Server

Interactive Dashboards

(traffic, air-quality & meteorology, pavements)



Roadway Pavement Assessment

Participatory Sensing

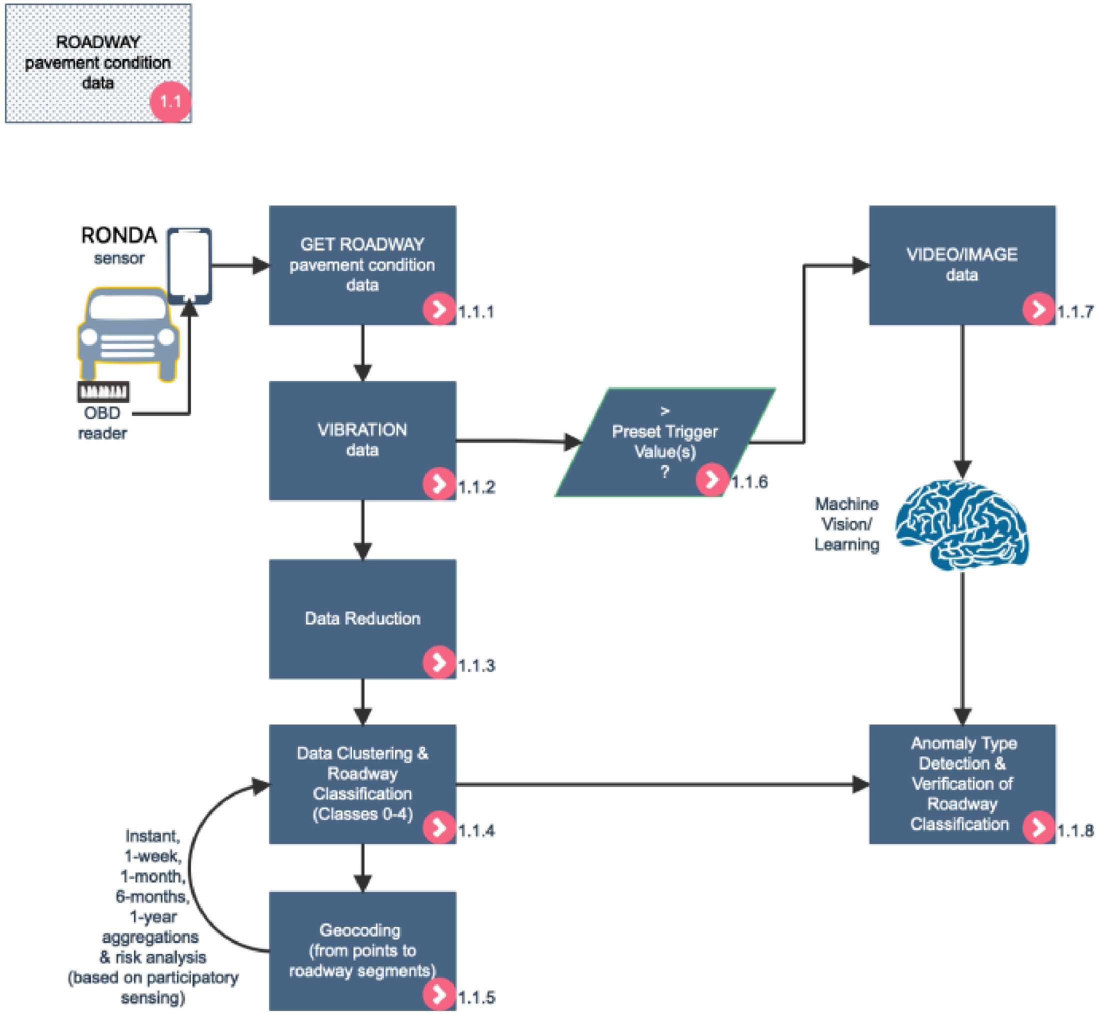


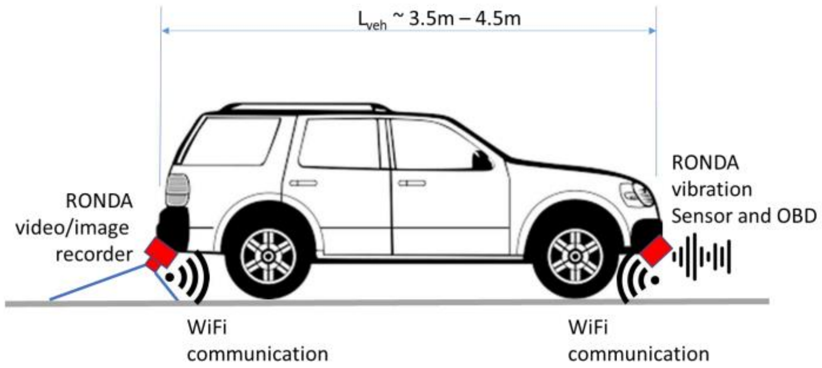
Figure 18. RONDA-DSS architecture (Level 1.1 – RONDA-DSS/TIA).

Table 3. RONDA-DSS process details (Level 1.1 – RONDA-DSS/TIA)

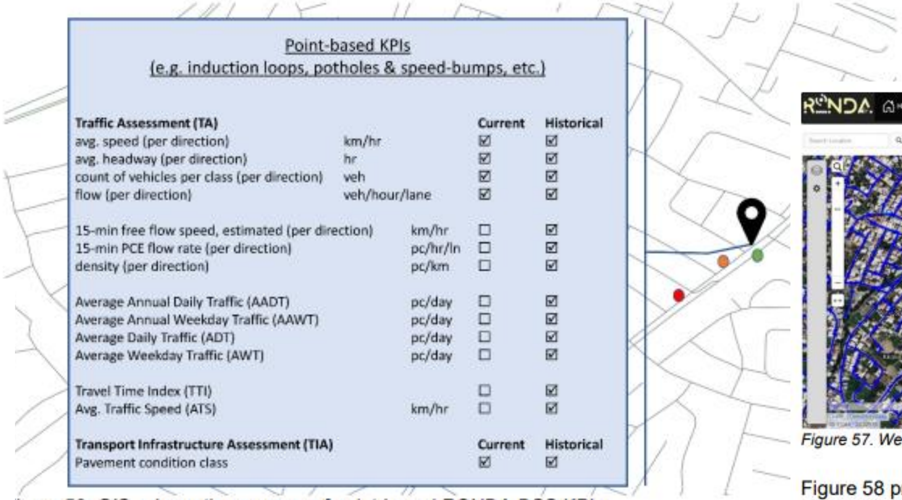
Process Id	Key Characteristics
1.1.1	• Choice of RONDA-custom sensor (case of automated processing), or of generic smartphone plus OBD (case of manual processing).
1.1.2	• A typical 30-min drive generates vibration datasets of about 50,000 rows (~20MB).
1.1.3	• The data reduction process aggregates data to buffered points, reducing the dataset (of Step 1.1.2) to about 1200 datarows.
1.1.4	• The classification process produces subsets of points in one of five roadway pavement condition classes: <u>Class</u> <u>Roadway Pavement Condition</u> Class '0' : Excellent Class '1' : Good Class '2' : Fair Class '3' : Poor Class '4' : Failed • The performed spatial clustering is based on a number of key data parameters and on variable methods, each time intelligently selecting the classification methods producing the highest clustering performance metrics and the highest number of incidents in the top two worst classes. • The clustering process should be performed at periodic intervals, to account for participatory sensing and to increase the accuracy of the process. Roadway assessment data is to be processed at the end of each day, at 1 week, 1 month, 6 months and at 1 year, with the corresponding condition appraisal values weighed and stored accordingly.
1.1.5	• The detected point roadway anomalies are geocoded to the nearest street segment (and street direction).
1.1.6	• The vibration sensor triggers a 10s-30s video recording of the corresponding roadway pavement. The trigger value(s) should be adjustable through a two-way communication between the platform and the sensor, to allow for experimental optimization.
1.1.7	• The dropped video is split into images, for further processing based on machine vision.
1.1.8	• The dropped images are analysed by use of machine vision (MV), for the existence of typical roadway anomalies (e.g. cracks, patches, potholes, bumps). The MV-based detected roadway anomaly is then used to confirm (and/or reclassify) the GIS location of the corresponding image.

Roadway Pavement Assessment

Participatory Sensing



Custom-developed, low-cost, sensors for point and segment-level roadway condition assessment based on vibration sensing and machine-vision



Point-based KPIs
(e.g. induction loops, potholes & speed-bumps, etc.)

Traffic Assessment (TA)		Current	Historical
avg. speed (per direction)	km/hr	☑	☑
avg. headway (per direction)	hr	☑	☑
count of vehicles per class (per direction)	veh	☑	☑
flow (per direction)	veh/hour/lane	☑	☑
15-min free flow speed, estimated (per direction)	km/hr	☐	☑
15-min PCE flow rate (per direction)	pc/hr/ln	☐	☑
density (per direction)	pc/km	☐	☑
Average Annual Daily Traffic (AADT)	pc/day	☐	☑
Average Annual Weekday Traffic (AAWT)	pc/day	☐	☑
Average Daily Traffic (ADT)	pc/day	☐	☑
Average Weekday Traffic (AWT)	pc/day	☐	☑
Travel Time Index (TTI)		☐	☑
Avg. Traffic Speed (ATS)	km/hr	☐	☑
Transport Infrastructure Assessment (TIA)		**Current**	**Historical**
Pavement condition class		☑	☑

igure 52. GIS schematic summary of point-based RONDA-DSS KPIs.

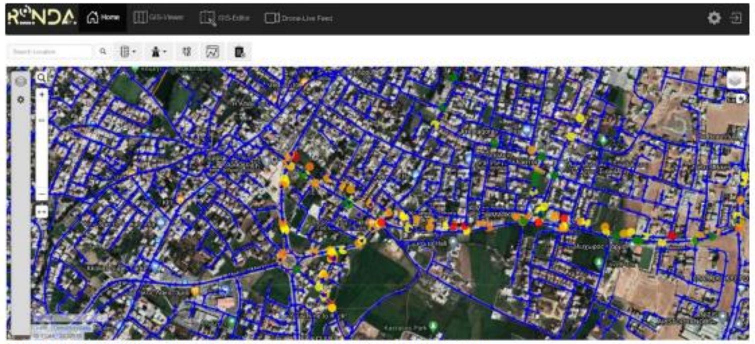


Figure 57. WebGIS - Pavement Assessment (location-based level).

Figure 58 presents an example of the pavement assessment results using a heatmap representation.

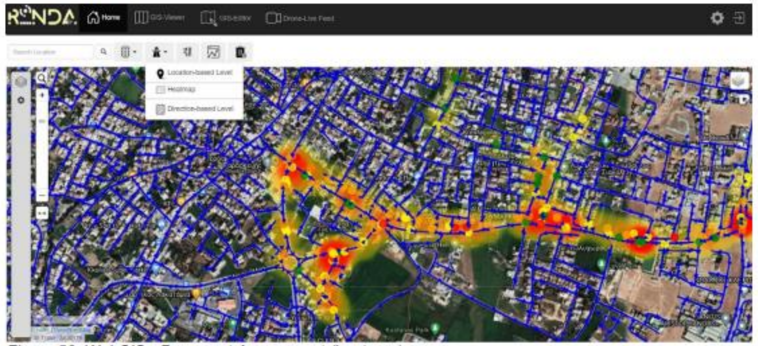
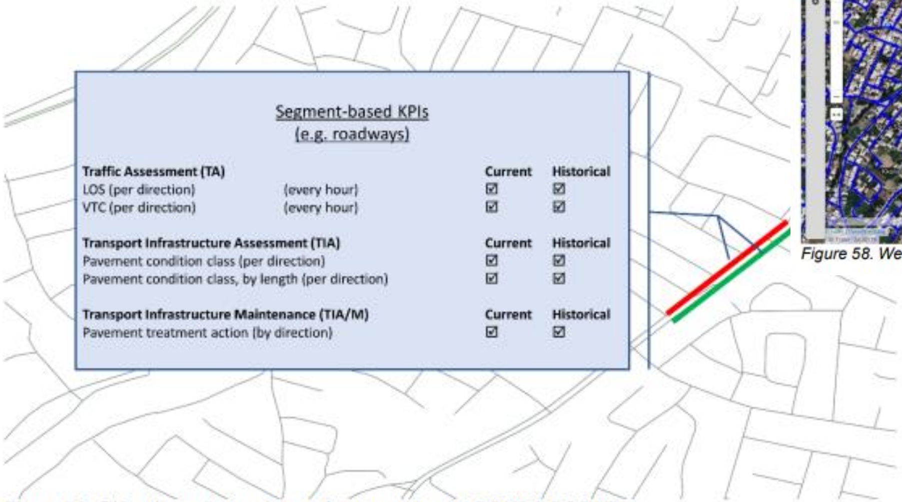


Figure 58. WebGIS - Pavement Assessment (heatmap).



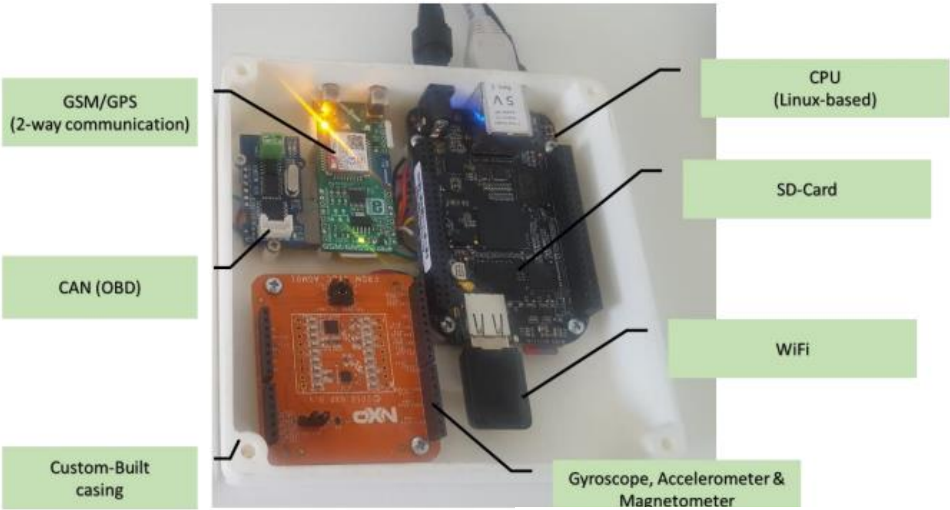
Segment-based KPIs
(e.g. roadways)

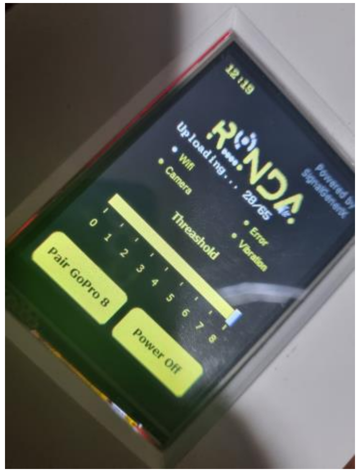
Traffic Assessment (TA)		Current	Historical
LOS (per direction)	(every hour)	☑	☑
VTC (per direction)	(every hour)	☑	☑
Transport Infrastructure Assessment (TIA)		**Current**	**Historical**
Pavement condition class (per direction)		☑	☑
Pavement condition class, by length (per direction)		☑	☑
Transport Infrastructure Maintenance (TIA/M)		**Current**	**Historical**
Pavement treatment action (by direction)		☑	☑

Figure 53. GIS schematic summary of segment-based RONDA-DSS KPIs.

Roadway Pavement Assessment

Participatory Sensing





Pavement anomalies detected

Rutting

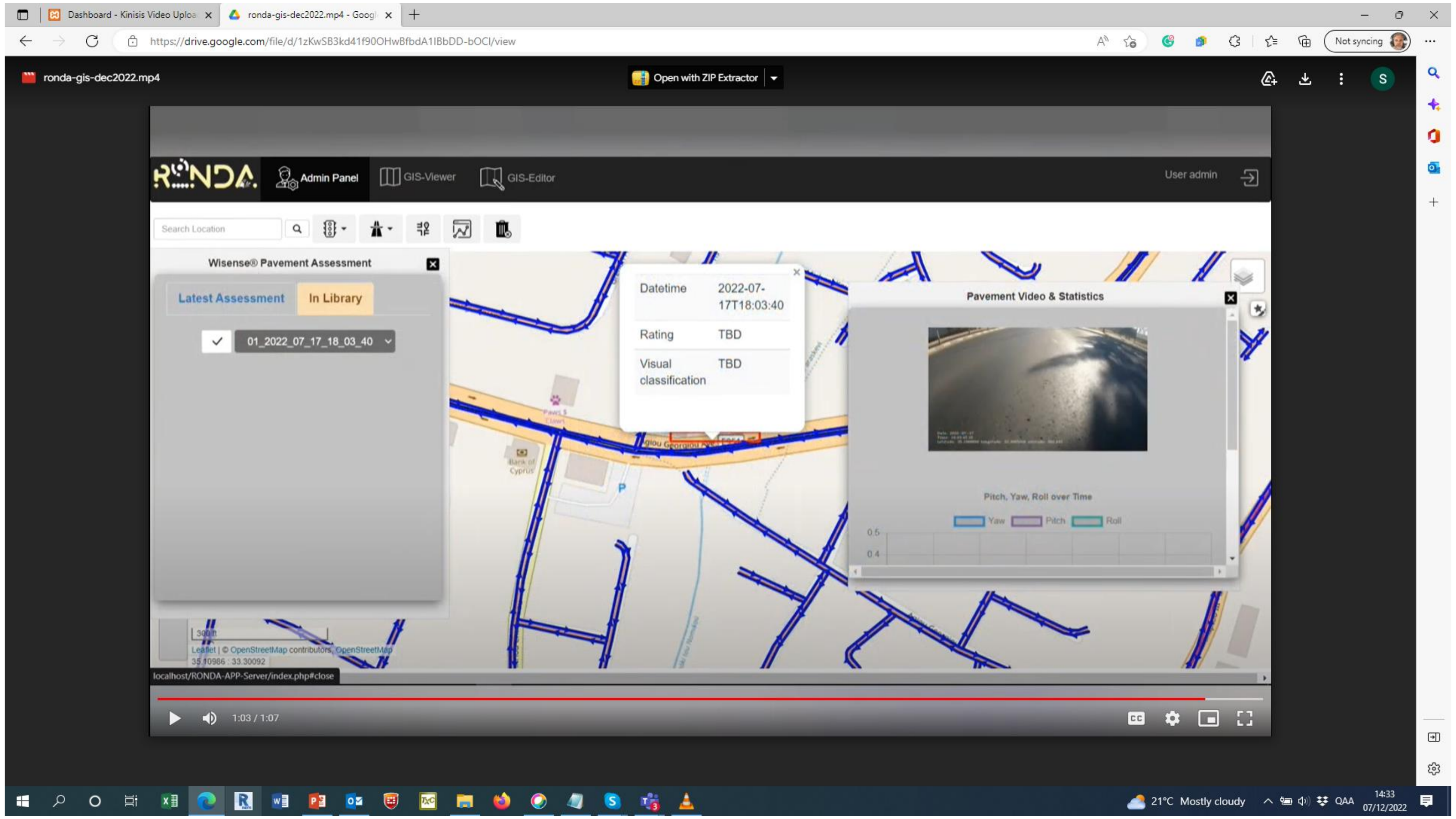
Cracks

Patches

Ravelling

Potholes

‘*kinisis*’ webGIS preview



Motivation

- **Traffic monitoring enables a wealth of applications in ITS**
- **Information Services:**
  - Incident information
  - Travel time estimation
- **Control Services:**
  - Traffic signal control
  - Navigation
  - Ramp metering
- **Traffic monitoring technologies limitations**
  - Installation time and cost
  - Traffic Disruption
  - Device cost
  - Scarcity of spatio-temporal measurements
  - Specific measured traffic parameters (flow, speed, density, turning ratios)

Promising technology: UAV traffic monitoring

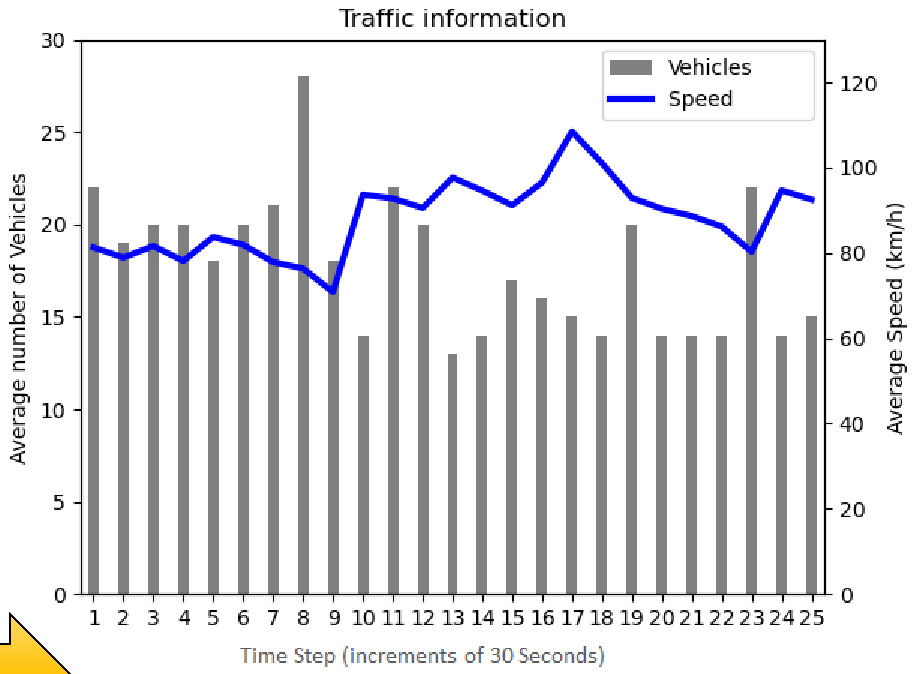
- **Advantages**
  - Cost comparable to conventional devices
  - No installation burden
  - No traffic disruption
  - Dense spatio-temporal measurements
  - Detailed vehicle level-information
- **Rapid traffic monitoring**
  - Intelligent processing of data captured from drone

Intelligent Data Processing

Gather Data

Leverage **Artificial Intelligence** and **Machine Learning** to create vehicle detection algorithms

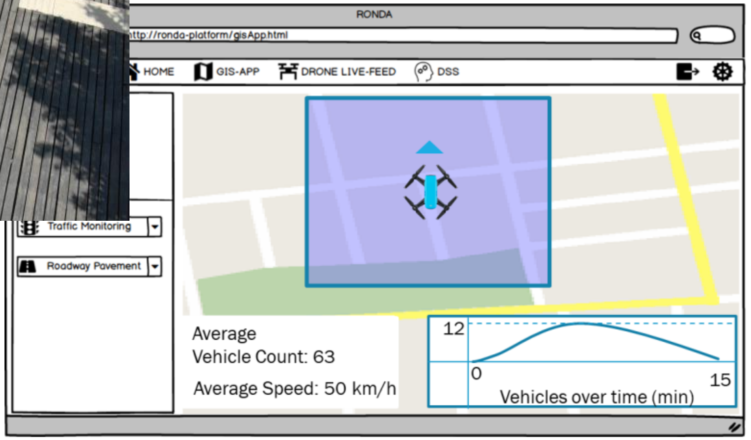
Extract Analytics/Statistics to Database



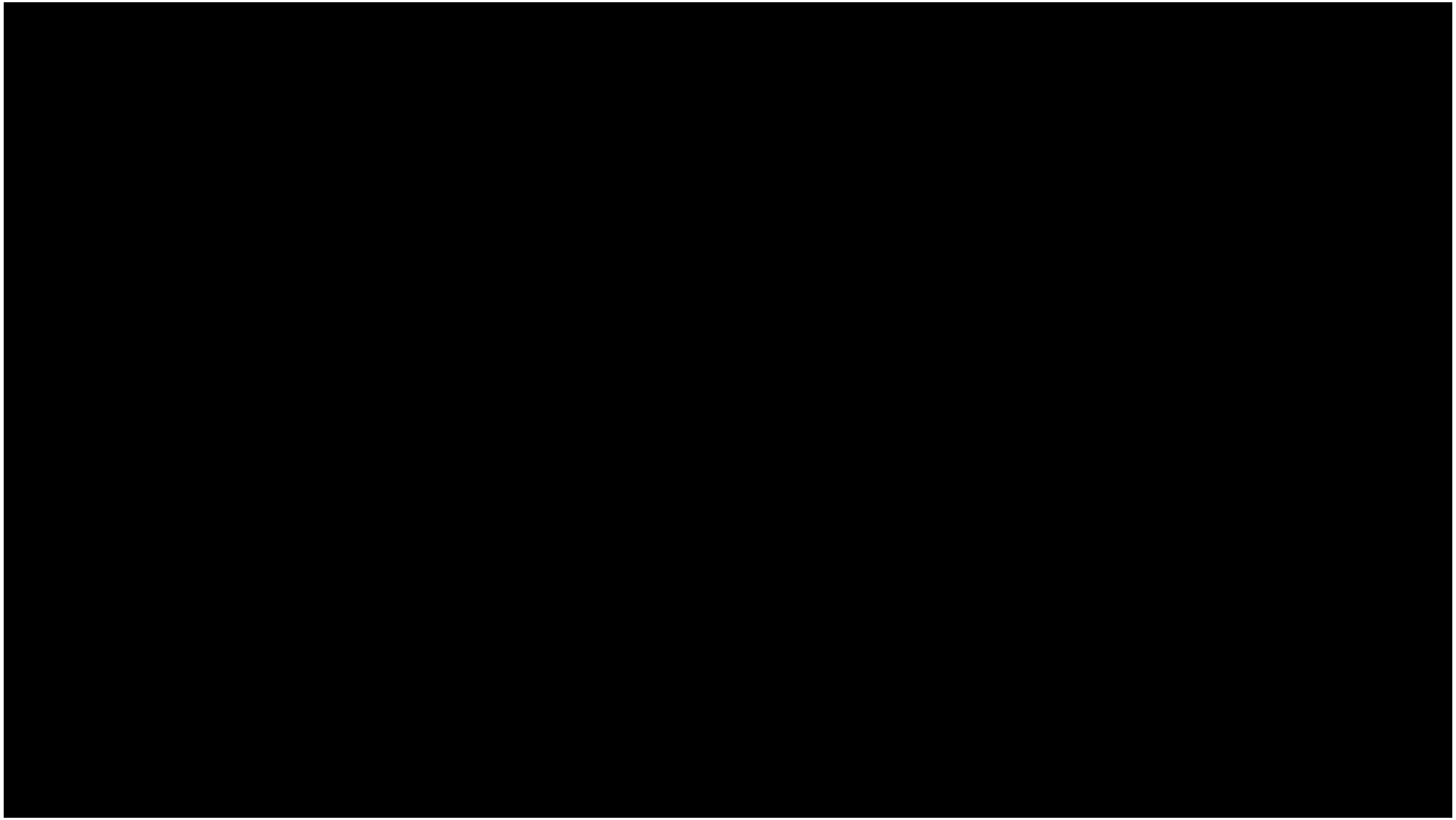
Towards an autonomous monitoring platform

- Small drone flies autonomously to the requested location
- Capture traffic video data, receive video and process it in real time
- Autonomous Return and landing on charging stations
- Integrate output into a decision platform
- Swarm of drones can cooperate to cover multiple areas





Data Analysis Capabilities



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