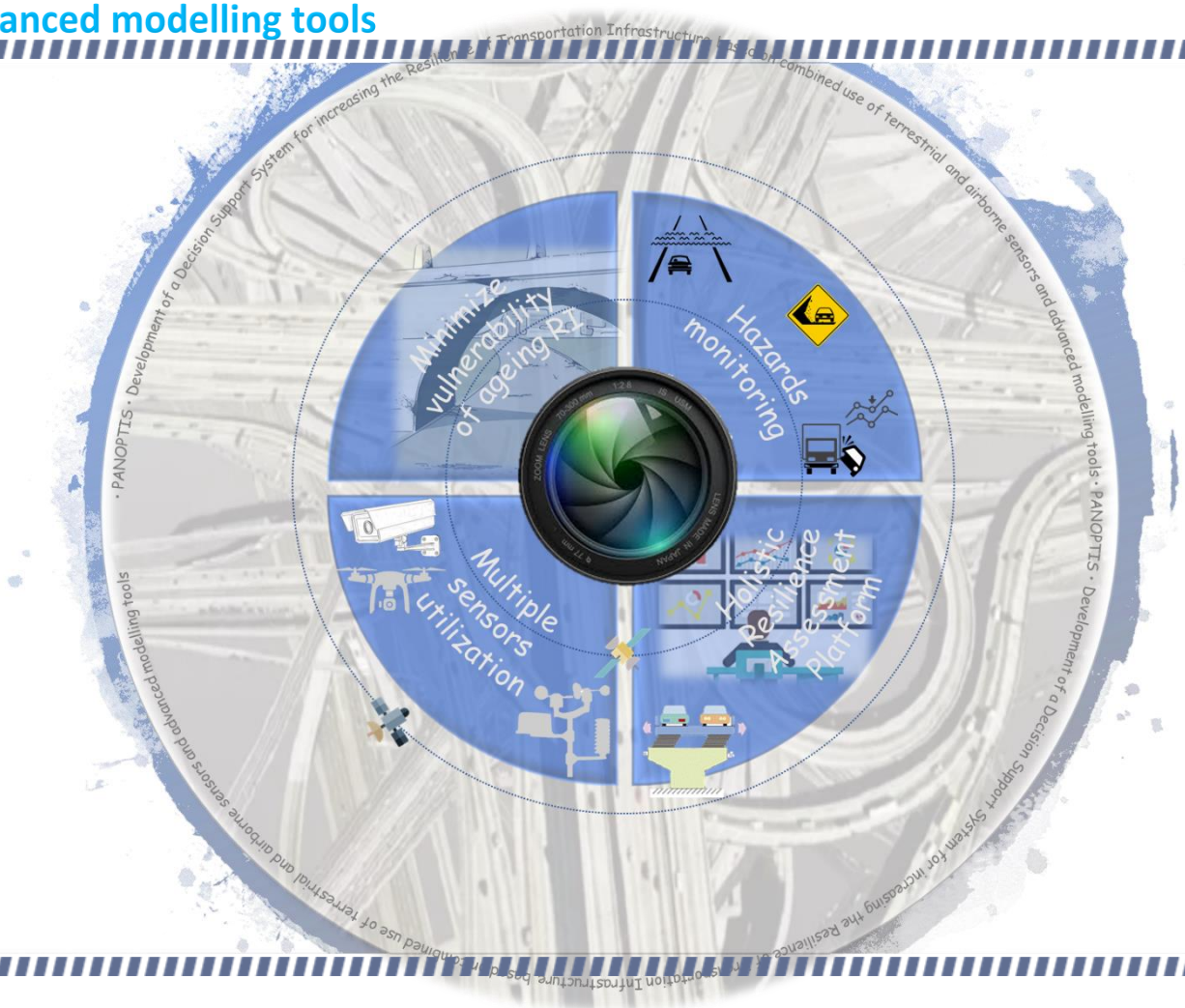
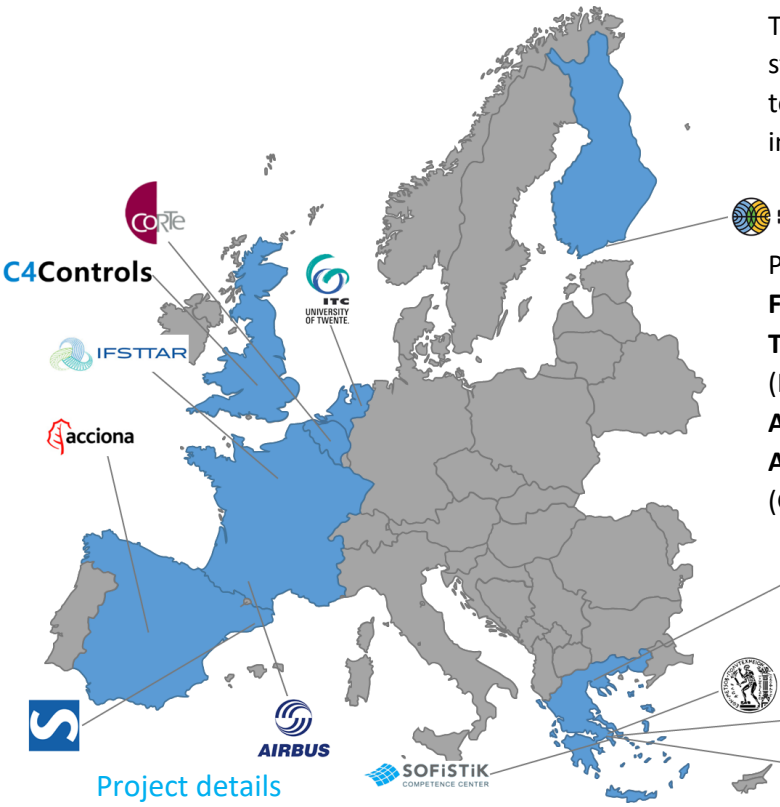
Development of a Decision Support System for increasing the Resilience of Road Infrastructure based on combined use of terrestrial and airborne sensors and advanced modelling tools



PANOPTIS mission is to leverage existing tools and services (e.g., climate models, modelling of extreme events and their impacts, Early Warning Systems (EWS), Structural Health (SH) / environmental monitoring sensors and EU services, such as Copernicus), as well as, novel technologies (terrestrial and satellite imaging for road infrastructure (RI) inspection, advanced machine learning and data fusion techniques, etc.) in view of a delivering an integrated platform that can be applied to RI, addressing multi-hazard risk understanding, smart prevention and preparedness, and faster, adapted and efficient response. Our proposed new integrated system aims to increase the resilience of RI/TI5 to support operational and strategic decisions, by better absorbing and efficiently recovering from damages.

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under grant agreement no769129.



Project details

PANOPTIS is being developed by a multi-disciplinary team, coordinated by AIRBUS DS SAS, in the EU's Horizon 2020 framework. The project was launched in May 2018 and will run for three and a half years (forty-two months), to allow enough time for the development and validation of the applied technologies.

The project emphasizes on the utilization of state-of-the-art machine learning/simulation techniques and drones to assist operators in infrastructures monitoring related activities.

PANOPTIS Consortium

Project Partners include: **AIRBUS DS SAS, Institut Francais Des Sciences Et Technologies Des Transports, De L'amenagement Et Des Reseaux** (France), **the National Technical University of Athens, EGNATIA ODOS AE, SOFISTIK HELLAS AE,** and **Aristotelio Panepistimio Thessalonikis** (Greece), **ACCIONA CONSTRUCCION SA** (Spain) **Hydrometeorological Innovative Solutions** (Spain), **Future Intelligence Ltd**, **C4controls Ltd** (United Kingdom), the **University of Twente** (Netherlands), **ILMATIETEEN LAITOS** (Finland), **Confederation of Organisations in Road Transport Enforcement** (CORTE) (Belgium).

Future challenges

One of the greatest challenges facing transport operators and engineers today is the fast and efficient inspection, assessment, maintenance and safe operation of existing infrastructures

Topology of Network Smart Tags, Micro-climate stations and connected components in RI hotspot

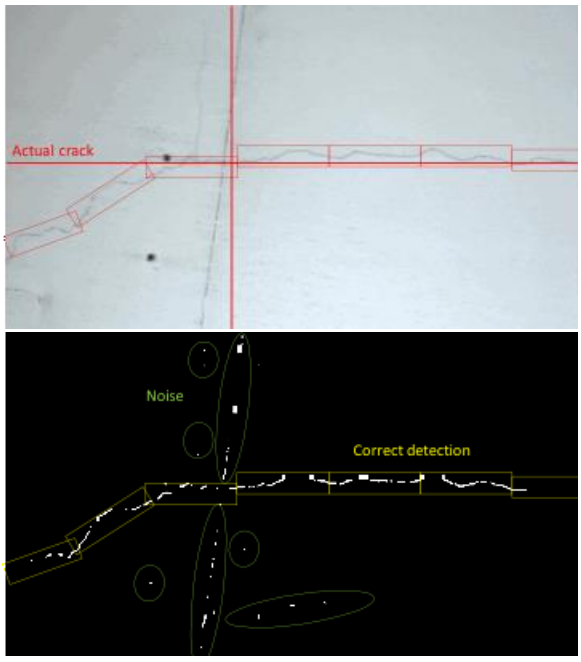
including highways and the overall RI network. Due to factors such as ageing, Climate Change (CC), extreme weather conditions or other natural and manmade hazards, increased traffic demands, change in use, inadequate maintenance and deferred repairs, the Transport Infrastructures (TI) – including also railways, marine infrastructure, etc. – are progressively deteriorating and becoming more vulnerable, urgently needing inspection, assessment and repair work.

Left: Pre-and post-disaster satellite image showing extensive road damage (Hurricane Irene, 2011)

Down: IMS, risk/impact assessment simulation and 3D COP representation in a unified environment

PANOPTIS Technologies

- Climate, Atmospheric Forcing and Multi-Hazard Modelling
- Networked micro-climate and smart tags
- Fore-Now/Casting Weather Predictions methods and tools
- Geotechnical and Structural Simulation Tool (SGSA)
- Multi-Hazard Vulnerability Modules and Assessment Toolkit for RI (Geo)Structures
- Quick Assessment Damage Maps
- Improved multi-temporal, multi-sensor observations with robust spectral analysis, computer vision and Machine Learning (ML) damage diagnostic for diverse RI
- Detailed and wide area transport asset mapping, integrating state-of-the-art mobile mapping and making use of Unmanned Aerial Vehicles (UAV) technology
- Holistic Resilience Assessment Platform – HRAP
- Enhanced Visualization Common Operational Picture (COP), Incident Management System (IMS) and Decision Support System (DSS)



Up: The RGB image from a tunnel. Down: ML annotations

Spanish demo case on A2 Highway

The demo site in Spain is a section of the A2 Highway in Spain that connects Madrid with Barcelona. The selection has been done based on how crucial it is for the RI/TI system of Spain, as it connects the two largest Spanish cities, and its potential to be affected by a broad range of (mostly weather-related) events having already caused important damage, such as a bridge collapse due to flooding. The demonstration activities will be focused on the 77.5 km long section in the province of Guadalajara managed by ACCIONA.

The PANOPTIS system will be employed in the optimization of the winter road maintenance and deicing operations, very costly in this region due to the high frequency of frost and snow events; the monitoring and control of critical infrastructure (e.g. embankments) to ensure its stability and prevent certain failure events (e.g. landslides) intensified by extreme weather conditions; and the application of UAV-surveying and mapping in routine maintenance of different road elements (road surface, slopes, drainage).

Greek demo case on Egnatia Motorway

A section of the Egnatia Motorway in the Northern part of Greece will be used as a test case, selected due to the high exposure of its structures - bridges and geotechnical works (high embankments, big cuts) - and their increased vulnerability to catastrophic seismic events, high annual precipitations that affect active landslide areas, traffic overloading, and geotechnical movements (landslide, settlements, rock-falls). Given the high seismic loads in this region, the demo trials will focus, on structural/geotechnical assessment of bridges and geotechnical works under the combination of earthquake and landslide; application of the SGSA simulator on each one of the most representative hot-spots of the road infrastructure, namely: slopes, auxiliary bridges, tunnels, and drainage systems; and the validation of the computer vision, machine learning and UAV technologies for improved inspection of these hot-spot elements.

Spanish demo case on A2 Highway

Greek demo case on Egnatia Motorway