SPACE FOR INFRASTRUCTURE – AIR, LAND & SEA TRANSPORT INFRASTRUCTURE USE CASES

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Reference	Space for Infrastructure/Transport/Annexes
Issue/Revision	1 . 0
Date of Issue	05/07/2023
Status	Approved

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1. INTRODUCTION

This document lists the use cases to be used as part of the “Air, Land & Sea Transport Infrastructure” thematic area within the umbrella of the “Space for Infrastructure” thematic call for proposals.

The use cases presented result from the cooperation between the European Space Agency (ESA) and key stakeholders of the transport infrastructure sector. It aims at developing sustainable services leveraging space assets to address the needs for modern day transport infrastructure.

2. ANNEX A: AIR TRANSPORT INFRASTRUCTURE USE CASES

2.1. Aeroporti di Roma

2.1.1. Use Case 1 – Airport Digital Twin

To implement a digital twin of the airport for monitoring real time transport/assets/people movement, with possibility to deep dive into key data, make pivotal analysis, understand bottlenecks and implement ‘what if’ scenarios. Some examples of digital twin applications are:

- Airside digital twin: aircraft, ground handling and other operator’s airside vehicles
  - Benefit example: safety monitoring.
- Landside digital twin: public means of transport as well as private ones
  - Benefit example: optimizing intermodal integration.
- Terminal digital twin: passengers and operators real time flow monitoring from curbside to gate
  - Benefit example: bottleneck management through infrastructure optimization.

Note: solutions addressing only one of the digital twins above (e.g. only airside digital twin or landside digital twin) or also a mix of them (e.g. airside and landside digital twins) are supported.

2.1.2. Use Case 2 – Georeferenced Survey of Airport Infrastructure

Airport georeferenced survey (rolling updates, e.g. twice a year), comprehensive of airside, terminals, landside, hotels/offices/other buildings. The output has to be updated on a rolling basis and each 3D building has to be integrated into its BIM model.

- Benefit example: integrate BIM in a wider environment, making each system/ building integrated to the next one, making plano-altimetric surveys easier and always up-to-date.

2.1.3. Use Case 3 – Real-time Situation Monitoring

Monitoring airport construction sites in “real time” and airport surroundings.

- Benefit example: time saving on site inspections; safety monitoring.

2.1.4. Use Case 4 – Monitoring Environmental Impact

Monitoring environmental impact of airports (e.g. terminal system green performance - energy, internal air quality, external air quality)

- Benefit example: real time green awareness and possibility to take infrastructural measures to optimize the performance.

3. ANNEX B: LAND TRANSPORT INFRASTRUCTURE USE CASES

3.1. MIMIT – Genova & L’Aquila

The development of a real-time urban monitoring system as well as decisional support system (DSS) for the efficient management of emergency situations such as fire events, heavy rains, floods, droughts as well as anthropic activities is proposed. The goal is to optimize the use of transport infrastructures, reducing traffic congestion and facilitating the outflow and re-routing by sending notifications to citizens and civil protection in the event of major disruption, increasing the resilience of the land transport infrastructure.

Scenarios such as water bombs and the flooding of rivers or streams should be taken into consideration to identify areas at risk in advance and provide indications of outflow or deviation. This monitoring system will allow risk situations to be anticipated, optimizing urban mobility, and facilitating the outflow of private vehicles. It will be able to send timely information to citizens to avoid risk areas and secure themselves, as well as provide indications to civil protection for rapid interventions through the fastest access routes.

Notifications will be sent via dedicated apps or via messaging platforms such as WhatsApp, Telegram, Signal, and social networks media such as Facebook, Instagram, and Twitter. The notifications will provide real-time indications to avoid risk areas or get to safety if already present in such areas. The system can use space assets to enable to solution. Examples include:

- Earth Observation for road detection and planning.
- Satellite communications for real-time ubiquitous connectivity.
- Satellite navigation to provide precise navigation services.

These space assets in turn will enable the solutions' innovative technologies. Anticipated technologies to be included are:

- Digital Twin
- Artificial intelligence
- Blockchain
- Internet of Things (IoT) devices.

3.2. Iveco Bus

3.2.1. Use Case 1 – Hydrogen Refuelling Infrastructure

Availability and accessibility of hydrogen charging infrastructure for hydrogen powered vehicles is still lacking in many parts of the world with few refuelling stations currently available. Users of Fuel Cell Vehicles (FCVs) need information about refuelling stations in their proximity and on hydrogen availability.

Satellite data can provide valuable information for both the strategic roll-out of new refuelling infrastructure as well as for the end users. Satellite data can assist users of hydrogen-powered vehicles in identifying the most optimal recharging station based on factors such as distance, traffic conditions, hydrogen availability and real-time updates on station capacity.

The integration of satellite data such as GNSS, earth observation or satellite communication into potential solutions will support users in making informed decisions, stimulate the uptake of hydrogen-powered vehicles, while supporting the growth and expansion of the hydrogen charging infrastructure.

3.2.2. Use Case 2 – Demand Responsive Transport and Route Optimization

Demand Responsive Transport (DRT) solutions allow the transportation system to operate in a flexible way, based on user demand, road and weather conditions. There is significant value in optimizing both the route and the timing of transport to provide more efficient and personalized options to users, as well as increased connectivity to low population density areas. Public transport operators can leverage real time information about traffic, road closures, user demand and location for optimizing the efficiency of their fleet.

Space-enabled solutions can add value to these solutions in the following ways:

- Satellite navigation provides positioning and navigation solutions to vehicles and can also be used to assess the flow of traffic through speed monitoring of vehicles. In addition, for the passenger user group, navigation can be used to provide a positional fix for pick-up/drop-off locations.
- Satellite communication can be used to communicate to vehicles to provide updates to vehicles operating in rural settings where terrestrial cellular networks are not available.
- Weather data can be one of the parameters integrated into the overall solution to give an additional layer of information to support decision making for alternative routes.

Overall, digital tools such as Digital Twins and AI solutions can combine terrestrial and space data to enable better fleet management and support with strategic decisions in both infrastructure roll-out and operations.

4. ANNEX C: SEA TRANSPORT INFRASTRUCTURE USE CASES

4.1. Port of Livorno (IT)

4.1.1. Planning and Monitoring Dredging Operations Infrastructure in Ports

This use case aims to develop an application to support the planning and monitoring of the operations of dredging, that is the removal of sediments and debris from the bottom of harbours. These operations are performed regularly as the accumulated sediment gradually fills the channels of the harbours. Space data combining water turbidity and other data with in-situ data may be able to provide to the stakeholders information on the status of dredging locations (e.g. ports and harbours) and the monitoring of the required infrastructure. This is particularly relevant as dredging may have environmental impacts such as suspended sediment leading to increased turbidity, loss of dredged material during transport, loss of aquatic fauna at dredging or placement sites. The information provided by this application may support the decision-making on dredging needs for a specific site assessing if there are unacceptable effects and if they can be sufficiently mitigated or compensated.

4.2. Port of Ravenna (IT)

4.2.1. Use Case 1 – Infrastructure Monitoring in Ports

This use case relates to monitoring infrastructure in ports with the purpose to lower the maintenance costs significantly. Space data and IoT solutions can add value to the information collected by sensors that continuously monitor the condition of critical machines, equipment, and other assets such as cranes. As response time is a critical factor, a 5G private network set-up could be used to receive data wirelessly from many sensors in real time, detecting any abnormalities and determining when an asset requires maintenance and when complemented by AI functions in edge controllers or cloud, will be able to identify critical situations based on several data points from the machine. Early detection of potential faults and their causes makes breakdowns a rare occurrence and minimizes response times when they do occur reducing on-the-ground monitoring efforts.

4.2.2. Use Case 2 – Monitoring Port Ecosystem Activities

It can be of vital importance to get accurate information on the development of new infrastructure in the ports as well as extensive activities related to existing infrastructure. Satellite data allow to monitor detailed changes in port infrastructure providing information on construction and