Developing Space Applications in the Transport Sector Under the European Space Agency's Integrated Applications Promotion (IAP) Programme

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ABSTRACT

The Integrated Applications Promotion (IAP) programme is a funding mechanism to promote the development of sustainable services that make use of two or more space technologies. It is based in the Telecommunications Directorate (TIA) of the European Space Agency (ESA). There is significant potential to develop services with industrial players in the transport sector and IAP is actively exploring collaborative activity in this domain, in concert with a variety of stakeholders including the Satellite Applications Catapult and the Transport Systems Catapult.

The potential role for space systems and services is often not fully recognised but many examples can be identified where space technology is already being used across the transport sector. The ESA IAP process is briefly described and summary information on example projects is presented. Funding opportunities under the programme have led to on-going IAP activities, which include projects covering such application domains as: railway systems and services; movement of dangerous or sensitive (e.g. pharmaceutical) goods; monitoring transport infrastructure; multi-modal transit through ports; maritime; and aviation.

An important part of IAP activities is to engage with new user communities and domains that have previously had little or no awareness or concern about space technology; and to identify applications where the space industry can fulfil particular needs or opportunities. Through this process IAP aims to develop synergistic links across these domains, worldwide. The projects outlined will clearly illustrate that space technology has great potential to help industry and service providers in the transport sector to implement applications that support business needs; to improve coordination; to reduce the cost of transport services; and to increase the resilience of associated infrastructure.

1.   Introduction

The European Space Agency (ESA) is Europe's independent, inter-governmental space organisation, with 22 member states and close links to the EU. ESA's purpose is to provide for and promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications.

At ESA the Integrated and Telecommunications related Applications Department (TIA-A) manages the IAP, SATCOM-APPS, and SAT-AIS programmes. In addition to awareness activities, these programmes are dedicated to the evolution of customised solutions and the establishment of innovative services, based on feasibility and demonstration projects. Programme activities are implemented co-operatively with institutional and private end users, solutions and service providers, and with other stakeholders such as European and international organisations. There is coordination with Member States and, where appropriate, with the European Commission.

The Transport sector provides an important opportunity to link ESA's twin foci on the development of space-based applications and downstream services. ESA actively engages with customers, service providers and service integrators in both the transport and space domains, to either develop new services in transport or improve existing ones.

Global trends indicate that the future of mobility will be very different from the way it is delivered at present. This change creates big new business opportunities, arising from the need to move people and goods more efficiently and sustainably, to meet a growth in demand that in turn is driven by lifestyle needs and more challenging targets for user satisfaction. Besides people and goods, the "things" being moved will also be able to communicate with each other. This means that an "Internet of Moving Things" will emerge, requiring that the energy, transportation and information and

communications technology worlds need to be integrated. One result is the development of new partnerships, with non-traditional players delivering future mobility services.

1.1   ESA and the Transport Sector

ESA has an outreach programme to increase awareness of and engagement with its programmes (not just within the UK but globally), among a wide range of potential user and stakeholder communities. As an example, ESA has embedded an IAP Ambassador Platform within the Satellite Applications Catapult Centre. It utilises this platform as an outreach mechanism and also as a gateway for developing horizontal linkages, for instance with the Transport Systems Catapult.

One of the principal focus areas of the UK Ambassador Platform is to help the IAP programme to spread awareness among stakeholders within the domain of "Enhanced Mobility". This covers the movement of people and goods by all means and for all purposes, whether by land, sea or air, under the two main headings of Personal Mobility and Intelligent Transport. In this context, space-enabled services can contribute to the creation of a mobile society that is safe, efficient, environmentally sustainable and well informed. Through this IAP Ambassador Platform we anticipate that entities will submit direct negotiation proposals to the ESA applications programmes like IAP, or will bid for ESA open competitions. The platform also acts as an incubator of new ideas, many of which may subsequently be developed through one or other of the ESA programmes.

In this way ESA is interested in the possibility of supporting and collaborating with various entities in the transport domain, to stimulate an increase in the number, variety and quality of ideas and project proposals that emerge. This could include discussion of target topics or communities; development of competitions, tenders or statements of work; technical and commercial evaluation of proposals; joint hosting of meetings or events; and other promotional activities. Through this mechanism ESA encourages wider engagement and project activity in the Transport sector, which ideally should include joint efforts to promote new space-based applications.

From several years of experience in incubating applications, services and products, the ESA ARTES programme has learned that many different types of support must be provided to increase the chances of success. Often the most intangible are the most important (e.g. advice on IPR, technical expertise, funding sources and how to engage with them, marketing, or customer information systems). It is easy to list these things but it is hard to make them practically available and doing so requires cooperation by multiple players. ESA is serious about its interest in achieving this by promoting links between players in the transport domain and those in other domains, including the space industry, other market sectors and wider geographical regions.

1.2   ESA Funding Opportunities

In the present context, the principal opportunity for stakeholders in the transport sector is the co-funding by ESA of activities aimed at developing new, space-based applications and services. This can be supported via a number of ESA's so-called "ARTES" programmes. ARTES (Advanced Research in Telecommunications Systems) is an overarching ESA programme intended to support the development and implementation of advanced satellite telecommunications products and services.

The Integrated Applications Promotion programme (IAP or ARTES-20), is the principal ARTES sub-programme that is frequently of relevance for the Transport sector. Others include the SATCOM-APPS programme (ARTES 3-4 Applications) and the wider ARTES 3-4 Telecoms Products programme, which addresses activities related to satellite communications; the SAT-AIS programme (ARTES 21); and certain other ARTES programmes such as those related to future air navigation (IRIS) and applications for new satellite systems (e.g. Alphasat, EDRS and Hylas).

The IAP programme promotes the development of new applications and services by integrating different available space assets with terrestrial systems, resulting in viable services for the benefit of society. To achieve this, the following objectives And requirements have been defined:
* Promotion of space applications to a wider range of users, especially those who are not aware of the benefits that space technologies can bring them;
* Development of new operational and economically sustainable services for these users;

- Utilisation of at least two existing space assets (such as Satellite Communications, Earth Observation, Satellite Navigation or Human Spaceflight technologies), leading to a better exploitation of existing space capacity and know-how;
- Co-funding by ESA and the industry and user partners that develop the solutions (typically 50/50 although the industry and user contributions are commonly in-kind); and
- Active user involvement in the development activities.

The aim of IAP is to ensure that user needs are satisfied by providing solutions that are technically and economically viable and cost effective. The types of activities funded through IAP are:

- Feasibility Study: devoted to provide the preparatory framework to identify, analyse and define potential new services. Special effort is spent on the investigation of their technical and economic feasibility.
- Demonstration Project: devoted to build the concept of the service developed during a Feasibility Study and to bring it to the point at which a viable operational solution can be deployed. Demonstration projects can also be undertaken directly, without a preliminary Feasibility Study.
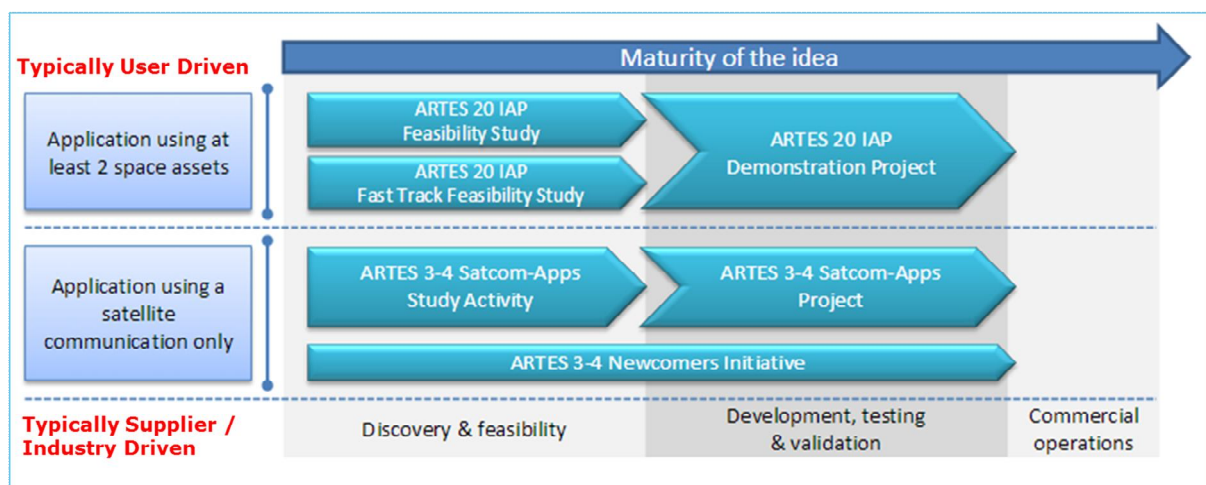

Chart 1a   IAP and ARTES 3-4 Funding Process

ARTES 20 IAP activities always start from a set of user needs that relate to a specific problem or opportunity, rather than starting from a particular technological solution. User consultation meetings may be needed. They aim to specify the dedicated user needs, generate the related user requirements and define the principle content of the studies.

2.   ESA IAP Activities in the Transport Sector

Transport is essential to modern civilisation. Yet modern society has realised that the ever-increasing demand for mobility cannot be met by simply expanding today's means of transport. Indeed, transport systems are major contributors to congestion, death and injuries from accidents, climate change, deterioration of ecosystems, resource exhaustion, and public health problems due to air pollution and noise.

Intelligent Transport Systems (ITS) can significantly contribute to a cleaner, safer and more efficient transport system. A new European legal framework (Directive 2010/40/EU)[1] was adopted on 7 July 2010 with the objective to accelerate deployment of innovative transport technologies across Europe and to establish interoperable and seamless ITS services. Member States are free to decide which systems to invest in but are expected to adopt specifications (i.e. functional, technical, organisational or services provisions) to address the compatibility, interoperability and continuity of ITS solutions across the EU.

Space-based systems, notably the use of Global Navigation Satellite Systems (GNSS or Satnav) and Satellite Telecommunications (Satcom), may increasingly help to meet mobility challenges based on innovative services. The ability to accurately determine and communicate one's position at any

moment thanks to GNSS, is starting to have a major impact on the management of ship and lorry fleets, road and rail traffic monitoring, the mobilisation of emergency services, the tracking of goods carried by multimodal transport and air traffic control.

The current ARTES Applications portfolio of activities contains approximately 140 transport related projects, which represents some 40% of the programme activities. Chart 2a presents an overview of the relative proportion of respective transport modes covered by these activities.
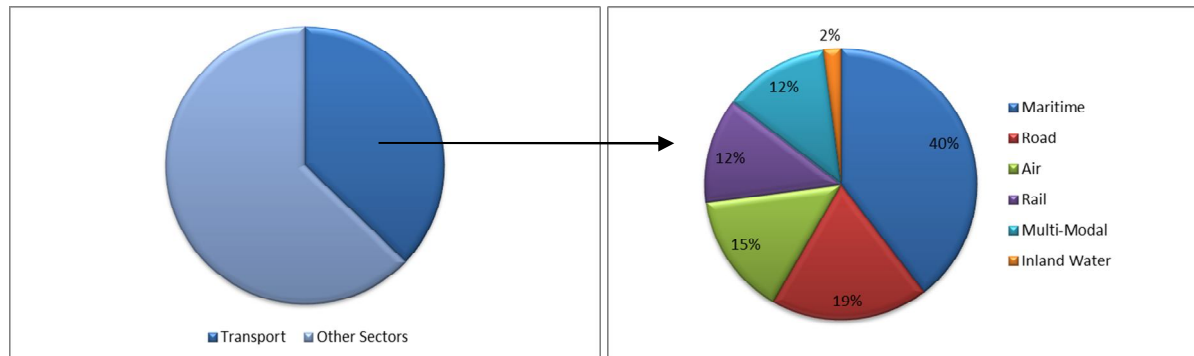

Chart 2a   ARTES Applications Activities in the Transport Sector

ARTES Applications activity in some specific components of the Transport sector are described below. Further information on individual activities is provided in Table 1 and is also available online at the ARTES Applications website[2] https://artes-apps.esa.int/projects

2.1   Rail

Railways need integrated positioning and communications for reliable and safe operations. To date, much of this has been provided using terrestrial means along tracks (e.g. GSM-R, balises). There is a need to increase safety and efficiency in order to achieve the increased capacity anticipated in the market. This is intrinsically linked to the introduction of the European Rail Traffic Management System (ERTMS): an initiative backed by the EU to enhance cross-border interoperability and the procurement of signalling equipment by creating a single Europe-wide standard for train control and command systems.

Yet this traditionally conservative sector (typified by very long lifecycles in rolling stock, demands for high reliability and heavy investments along the tracks) is having to face changes to achieve the new objectives. Deployed communications solutions are becoming obsolete and train control procedures are moving from fixed signalling to moving block signalling, which needs continuous knowledge of train position. There are growing needs to improve safety in regional and remote lines (e.g. safe level crossings), with limited terrestrial infrastructures and a trend towards advanced control systems (already adopted in advanced urban lines, e.g. driverless operations).

Satcom and Satnav can offer rapidly deployable solutions, with huge cost savings for infrastructure along the tracks. Satellite Earth Observation (EO) can contribute to monitoring the rail infrastructure and surrounding environment (e.g. for landslide risk). Space applications have in the past tended to be regarded as marginal to enabling improvements: but awareness is increasing thanks to a number of activities supported by ESA and others (see Chart 2b below). As a result, railway operators are becoming interested in the use of Space solutions for navigation and communications.
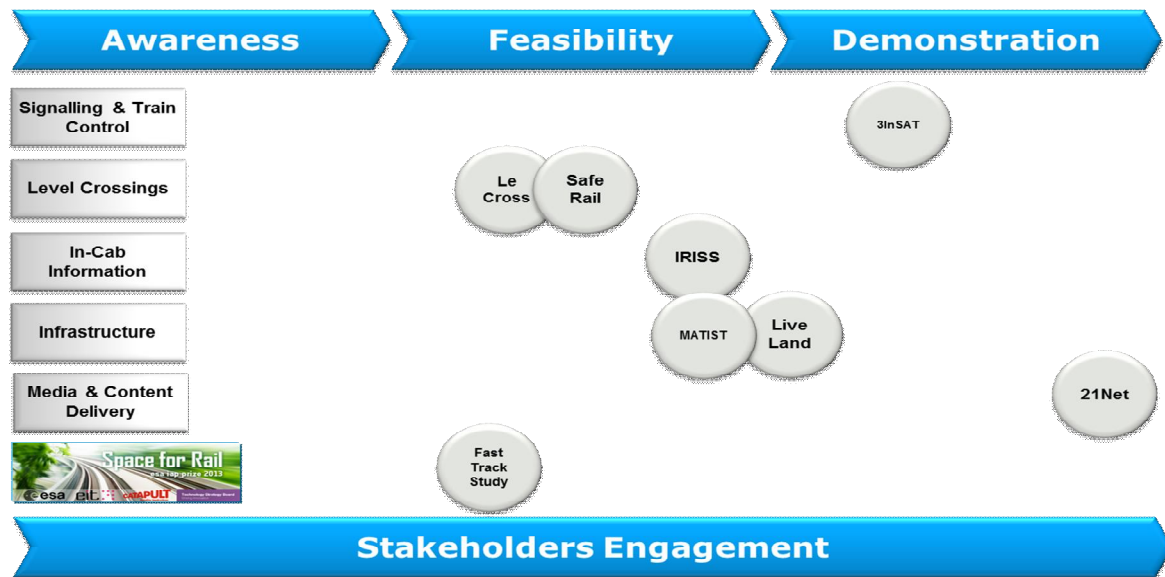
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Chart 2b   IAP activities in the rail sector

2.2   Integrated Logistics

The growth in global trade continues to increase the complexity of multimodal transport logistics. Inefficiencies in the transport system cause lost revenue and spoiled goods and have a negative impact on the environment. The UK Logistics Industry alone is estimated to be worth c. £93 billion and employs around 2.3 million people in over 196,000 companies[3]. Not only does Transport and logistics play a major role in the UK and global economy, there has also been a surge in public transport usage and a greater demand for effective and integrated transport / freight solutions. This is not just the physical movement of people and goods but also the collection and movement of associated data.

Many organisations have recognised that even minor improvements in the integration of transport logistics will have multiple benefits to stakeholders operating in the freight and transport sectors. It is also clear that the topic of reducing carbon emissions is emerging as a key issue to be addressed. A wide variety of projects have been funded by ESA IAP in this sector, as indicated by Chart 2c.
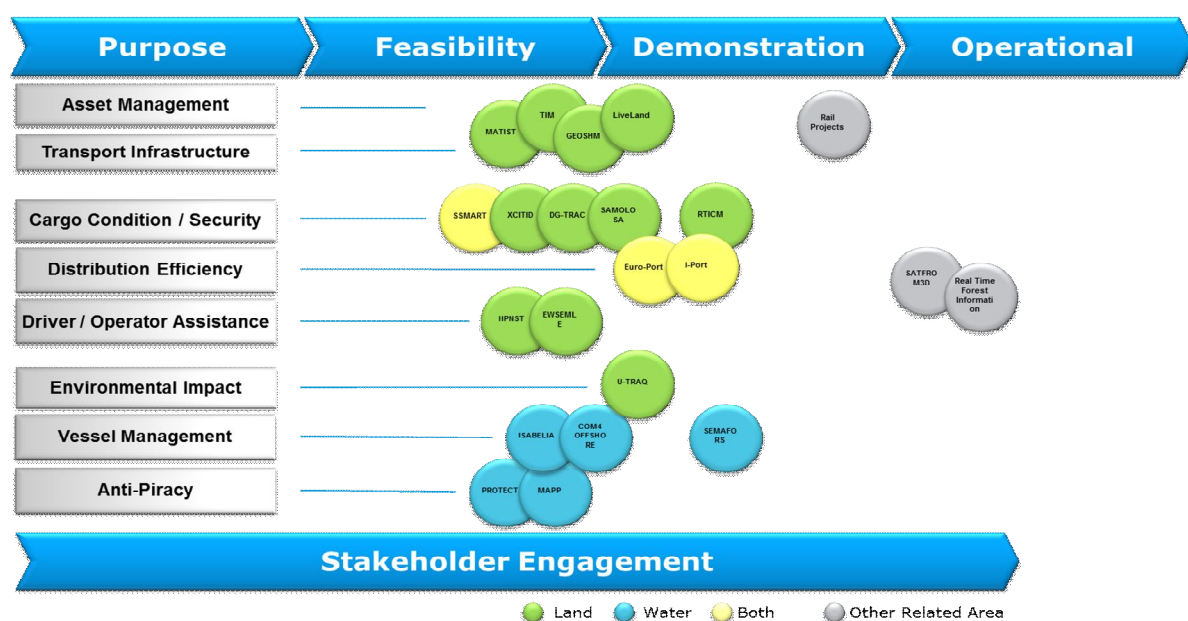

Chart 2c   IAP activities in the integrated logistics sector

2.3   **Maritime Operations**

Maritime services based on the integrated use of space-based systems are of interest to a wide range of user communities and classes: Fisheries, Coast Guards, Port Authorities, Military Bodies, Shipping Companies, Commercial Operators, International, National and European Institutions. The IAP, SATCOM-APPS and SAT-AIS programmes are engaging with several national and international end-user organisations who have expressed interest in satellite based services to complement and enhance their current capabilities. Examples include a partnership with the European Maritime Safety Agency (EMSA) relating to the use of the Satellite Automatic Identification System (AIS) for enhanced tracking of vessels by Coastguards and Customs agencies, leading to benefits such as faster port clearances for ships trading within European waters.

CONCLUSION

The Integrated Applications Promotion (IAP) programme is a co-funding mechanism to promote the development of sustainable services that utilise two or more space technologies in combination with terrestrial systems. It is based in the Telecommunications Directorate (TIA) of the European Space Agency (ESA). There is clear potential to develop services with players in the transport sector and ESA IAP is actively collaborating with a wide range of stakeholders in this domain.

The potential role for space systems and services is often not fully recognised but the ESA IAP process has led to many on-going activities, which include projects covering: railway systems and services; movement of dangerous or sensitive (e.g. pharmaceutical) goods; monitoring transport infrastructure; multi-modal transit through ports; maritime; and aviation applications.

An important part of IAP activities is to engage with new user communities that have little awareness of space technology and what it can do for them. ESA's IAP programme helps to identify applications where the space industry can fulfil particular needs and opportunities. IAP also helps to build synergistic links across different domains in the UK and beyond. The projects outlined show that space technology has great potential to help industry, service providers and users in the transport sector to implement applications and services that support business needs, improve coordination, reduce the cost of transport services and increase the resilience of associated infrastructure.

References

1. https://artes-apps.esa.int/projects

2. http://ec.europa.eu/transport/themes/its/road/action_plan/

3. http://www.skillsforlogistics.org/about/our-sector/

Endnotes: Table 1 - Examples of ARTES/IAP activities in the transport sector
Further details is available at the ARTES Applications website https://artes-apps.esa.int/

Project	Principal User Group	Mode	Notes	EO	NAV	COM	AIS	HSF
BIRDSTRIKE RISK	Multiple Customers	Air	Commercial airport safety operations	X	X			
DESIRE	Multiple Customers	Air	Multiple RPAS/UAV demonstrations	X	X	X		
SASISA	Emergency Services	Air	Search and Rescue		X	X		
FLYSAFE	Multiple Customers	Air	Military airfield safety operations	X	X			
PLANET2	Multiple Customers	Air	Meteo updates, electronic flight bag			X		
S2BAS	Multiple Customers	Air	Regional airport operations and capacity	X	X	X		
SELIAT	Emergency Services	Air	Helicopter landing sites for emergency ops	X	X	X		
SAFERDANUBE	Multiple Customers	Inland Water	River navigation, vessel operations	X		X		
PROTECT	Shipping Operators	Maritime	Anti-Piracy	X	X	X		
MAPP	Multiple Customers	Maritime	Anti-Piracy	X	X	X		
ISABELIA	Shipping Operators	Maritime	Baltic shipping situation awareness	X		X	X	
COM4OFFSHORE	Logistics Operators	Maritime	Wind farm installation and maintenance logistics	X	X	X		
SEMAFORS	Shipping Operators	Maritime	Vessel fuel efficiency via routing from metocean data	X	X	X		
ARCTICSAT	Shipping Operators	Maritime	Vessel operations : metocean data, position, comms	X	X	X	X	
BLUE BELT	Regulator	Maritime	EMSA, customs, vessel tracking				X	
CAESAR	Local Authority	Maritime	Search and Rescue support	X		X	X	
EASY	Multiple Customers	Maritime	Luxury yachting operations		X	X		
METSAR	Emergency Services	Maritime	Search and Rescue support	X	X	X	X	
PLASMA	Regulator	Maritime	EMSA, vessel tracking				X	
PROFUMO	Multiple Customers	Maritime	Ferry operations, metocean data	X	X	X		
SAMBA	Local Authority	Maritime	Vessel emissions		X		X	
SASS@SEA	Multiple Customers	Maritime	Reliable VSAT comms at sea			X		
SEA SEARCH	Regulator	Maritime	Search and rescue, vessel tracking				X	
ARCTIC IAP	Multiple Customers	Maritime	Arctic Ocean vessel operations	X			X	
NG-RMP	Regulator	Maritime	Vessel tracking			X	X	X
SIMONA	Multiple Customers	Maritime	Vessel tracking, common operational picture	X	X	X		
SAT AIS DPC	Regulator	Maritime	EMSA, enhanced AIS data & message handling				X	
MATIST	Asset Management Organisation	Multi-Modal	Transport Infrastructure - Alpine Tunnels, subsidence	X	X			
SAMOLOSA	Multiple Customers	Multi-Modal	Petrochemicals		X	X		
RTICM	Logistics Operators	Multi-Modal	Container security		X	X		
SSMART	Multiple Customers	Multi-Modal	Tracking dangerous goods transport	X	X	X		
I-PORT	Multiple Customers	Multi-Modal	Port logistics - wetside/dryside		X		X	
SAPI&NS	Emergency Services	Multi-Modal	Search and Rescue		X	X		
LIVELAND	Asset Management Organisation	Rail	Transport Infrastructure - road and rail subsidence	X	X	X		
SAFERAIL	Multiple Customers	Rail	Level crossing safety		X	X		
3INSAT	Rail Operators	Rail	Train location and signal control		X	X		
EOMST	Rail Operators	Rail	Broadband connectivity in moving trains			X		
IRISS	Rail Operators	Rail	Driver / operations efficiency, capacity management		X	X		
LECROSS	Multiple Customers	Rail	Level crossing safety		X	X		
TIM	Asset Management Organisation	Road	M25 / Dartford Crossing structural integrity	X	X			
GEOSHM	Asset Management Organisation	Road	Forth Road Bridge structural integrity	X	X			
Xcit'ID	Multiple Customers	Road	Chilled pharmaceuticals	X	X		X	
DG-TRAC	Multiple Customers	Road	Medical supplies and equipment		X	X		
EURO-PORT	Multiple Customers	Road	Port logistics - wetside/dryside	X	X	X		
HPNST	Logistics Operators	Road	Truck unit damage	X	X			
EWMSEMLE	Drivers	Road	Fuel Efficiency	X	X			
U-TRAQ	Local Authority	Road	Transport infrastructure, road congestion, air quality	X	X			
I-ENQUIRE	Multiple Customers	Road	Mobile apps delivered to drivers/vehicles via S-band			X		