

Role of drones in future Transportation and Logistics

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Washington, September 5th 2019

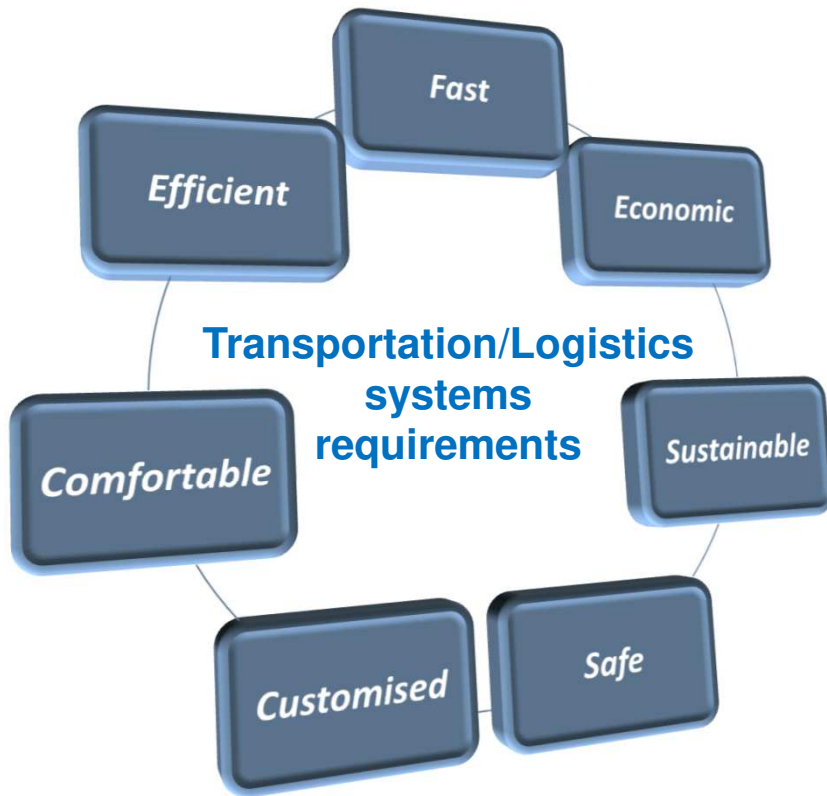


Summary

- Transportation & Logistics requirements**
- Autonomous & connected vehicles**
- Vertical markets / Potential applications**
- Transportation / Logistic systems enabled by Space Technologies**
- TPZ main UAS projects for smart cities**
- U-Space**
- Next step: Urban delivery Service Platform**



Transportation & Logistics requirements



MaaS – Mobility as a service

- ❖ 5G
- ❖ Smart Infrastructure
- ❖ IOT
- ❖ Artificial intelligence
- ❖ Cyber security
- ❖ Shared Mobility
- ❖ Autonomous Vehicles & Connected systems



Autonomous & connected vehicles



Farm vehicles



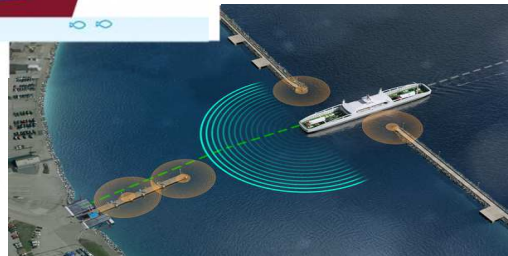
Railway transport



- ❖ 5G
- ❖ Smart Infrastructure
- ❖ IOT
- ❖ Artificial intelligence
- ❖ Cyber security
- ❖ Shared Mobility



Maritime transport



Self-driving vehicles

Road transport



Airships/Drones





Vertical markets / Potential applications



- Airships/Drones** → Urban monitoring, fleet management, urban delivery, infrastructure monitoring, etc. ...
- Maritime transport** → Autonomous navigation of unmanned ships (i.e. in the Arctic seas)
- Railway transport** → Self-driving trains, signalling systems
- Road transport** → Solution/service for autonomous driving, road traffic management, etc. ...
- Farm vehicles** → Precision agriculture with unmanned systems



Transportation / Logistics systems enabled by Space Technologies



Satellite Communication Systems

Telespazio contributes to **"hybrid" communication** integrating advanced multi-standard terrestrial communications, which also include the **5G standard**, with **satellite communication**. This is to ensure services to the vehicle in all conditions, even in rural areas and in emergency situations, where the terrestrial communication network could fail.

In unmanned system contest, satellite communication is able to support **BRLOS** functionality, either for command and control, either for transferring payload collected data (also needed in urban contest).

Earth Observation satellite data

Earth observation satellite data are able to feed **high precision Digital Surface and Terrain Models** (DSM, DTM), needed to grant a safe autonomous driving.

Satellite Navigation Systems

Telespazio aims to innovate and develop advanced navigation applications more **accurate, resilient** and **available**, leveraging new **multi-constellation accuracy satellite-based algorithms** (GPS+ GALILEO), as well as augmentation and data-fusion algorithms from on-board sensors and terrestrial surveillance systems.

Satellite navigation systems (EGNSS), with integrity and high accuracy performances, as well as with **augmentation capabilities, to allow for a precise guidance for unmanned systems**.

Cybersecurity

Satellite solutions can increase service **security and resiliency**. Satellite links can be effectively employed **to exchange security material** (authentication data, session keys, ...). **Fragmentation of highly sensitive data** (e.g. SW and Firmware updates) among a combination of terrestrial and satellite links **can increase robustness against spoofing and forgery**. Moreover, **satellite quantum communication** techniques can be used to transfer encryption keys for improving security.

Telespazio goal: to integrate applications based on a combination of satellite based capabilities, namely navigation, geo-information and telecommunication in a cyber secure environment, in order to *develop new services*.



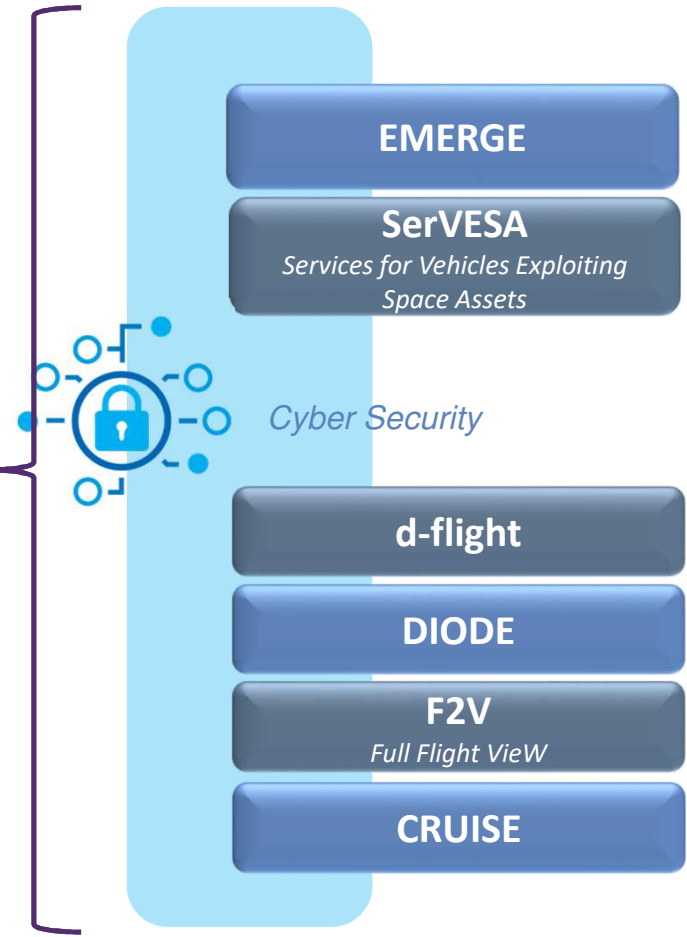
Telespazio main UAS projects for smart cities



AUTOMOTIVE



Drones





EMERGE *COMMERCIAL VEHICLES & EMERGENCY OPERATIONS: ADVANCED NAVIGATION, COMMUNICATION AND SECURITY*

With a perspective of a scientific and technological advancement in the field of ITS (Intelligent Transport Systems) applied to the automotive sector, the project foresees the development and test of applications for **"Connected"** vehicles based on GALILEO, 5G and Cybersecurity.

The EMERGE project will exploit

- the **satellite localization** and **sensor fusion** techniques, using the GPS-GALILEO-based multi-constellation;
- the ad hoc vehicular **communication technologies** and the current cellular network, going toward the incoming 5G;
- the **cybersecurity** techniques for intra-inter vehicular communication.

Telespazio is involved in supporting the activities of: supply and integration of the satellite system, analysis of future HTS constellation and of high precision localization and integrity services.

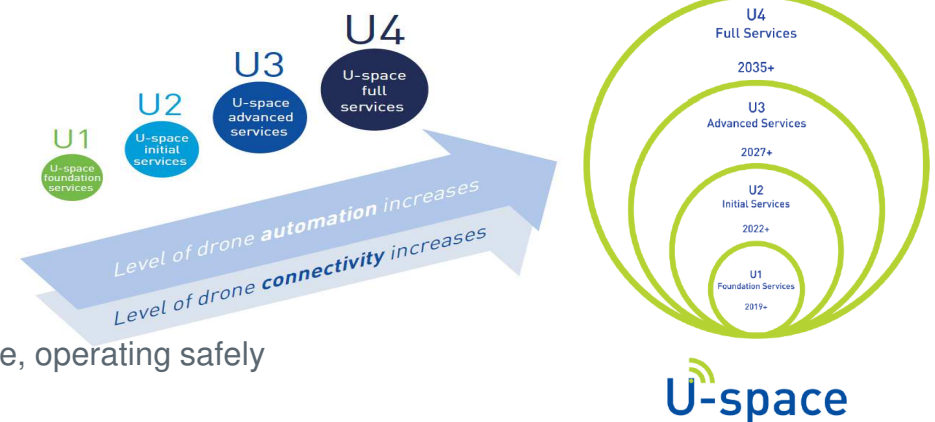




U-Space

- ❑ The growing drone marketplace shows significant potential: it is estimated that the European drone market will represent **EUR 10 billion annually by 2035** and **over EUR 15 billion annually by 2050**.
- ❑ The impact of **civil missions** (either for governments or for commercial businesses) is expected to generate the majority of this value as related services are anticipated to represent **more than EUR 5 billion of annual value by 2035**.
- ❑ Unmanned aviation technological developments are currently moving at a much faster pace than for manned aviation: mainly, some 7 million consumer leisure drones are expected to be operating across Europe, and a fleet of 400 000 is expected to be used for commercial and government missions in 2050.

- ❑ **U-space** is a **set of new services** relying on a high level of digitalisation and automation of functions and specific procedures designed to support safe, efficient and secure access to airspace for large numbers of drones.



- ❑ The goal is to have a seamless integration of drones into all classes of airspace, operating safely and efficiently alongside manned aircraft.
- ❑ **Manned and unmanned will be able to use the same airport infrastructure**; they will both communicate with ATC using datalink; rules and *procedures will be applied to both with some adaptations for drones as the pilot is on the ground*.
- ❑ **On June 11th 2019** common European rules on drones, Commission Delegated Regulation (EU) 2019/945 & Commission Implementing Regulation (EU) 2019/947, have been published to ensure drone operations across Europe are safe and secure.



- ❑ d-flight is a Joint Venture between ENAV (60%) and UTM S&S (40%), devoted to the provision of the Unmanned Traffic Management (UTM) services in Italy for UAS missions.
 - UTM S&S is an industrial company, Leonardo (66,7%) and Telespazio (33,3%), in charge of the development and operation of the digital platform to provide the d-flight services.

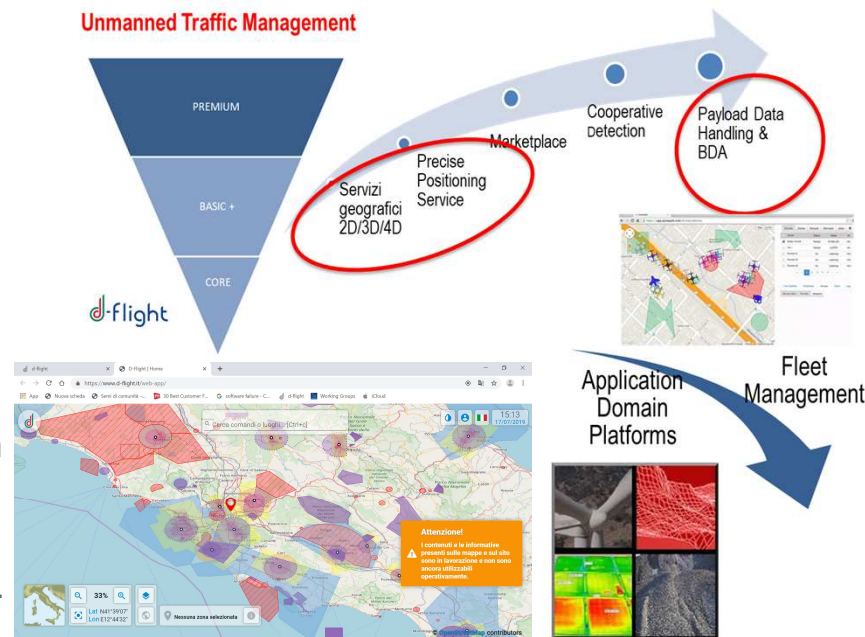
- ❑ The Users are:
 - Drone operators
 - Recreational users
 - Institutions

- ❑ The services follow the European U-Space roadmap

- ❑ The platform is already on-line (Rel. 1) (since July 2019)
 - Further releases are deployed with incremental approach

- ❑ The business model of the digital platform is based on:
 - On line services, market place, fee based or pay-per use.

- ❑ It is mentioned as reference platform by the national regulation on UAS use in Italy.



MARKETS

- Government & Agencies**
- ✓ UTM/ATM Service Providers
 - ✓ ANSPs

- Prosumer & Professional**
- ✓ Drone Operators
 - ✓ Drone Manufactures

- Vertical Business**
- ✓ Infrastructure Asset Management & Monitoring
 - ✓ Smart Farming
 - ✓ Emergency Management
 - ✓ Urban Air Delivery
 - ✓ Urban Air Mobility

F2V – Full Flight View

F2V project aims to test new solutions supporting the *safety of drones flight operations* and to develop *innovative applicative products* and *services* aimed at *territorial control* with state-of-the-art utilization and accuracy modes.

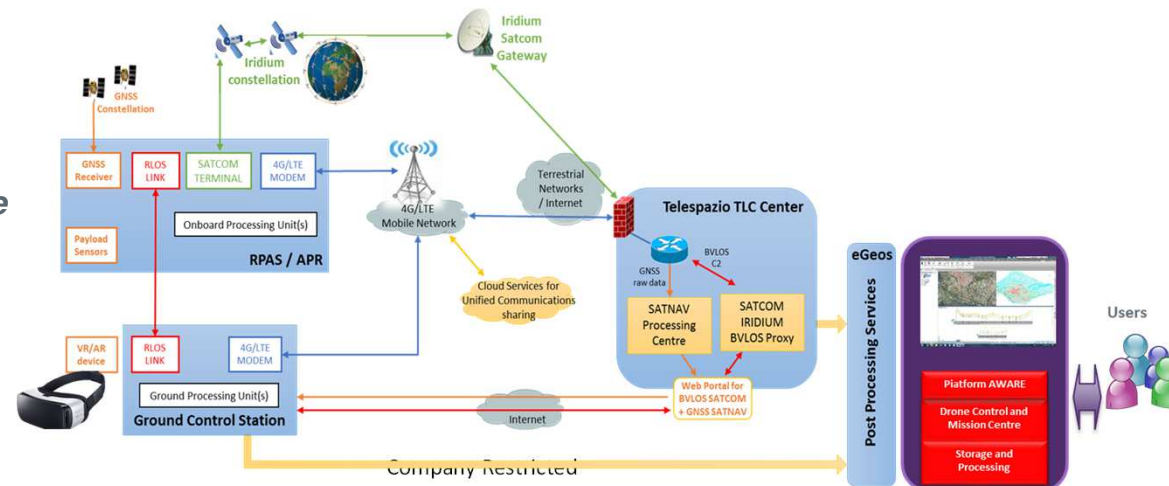
F2V has been approved within the **Torino City Lab** initiative, promoted by the **Municipality of Turin**, **ENAC**, **TIM** and the **Polytechnic of Turin** and it is entirely funded by the companies of the industrial team **led by Telespazio**.

Industrial Team



The project proposal was **approved** by Torino City Lab commission on 12th June 2019.

System Architecture



Company Restricted



F2V

F2V – Platforms and Payloads

Platforms

The experimentation activities envisage the use of various **fixed-** and **rotary-wing** RPAS platforms.

The tests carried out to date amount to over two hours for fixed-wing types (over 150 km of flight) and to over one hundred minutes for rotary-wing types (over 10 km of flight).



Payloads



Iridium satellite terminal - satellite connectivity to guarantee the transmission of the drone position and of control commands in a BVLOS (Beyond Visible Line Of Sight) operational scenario also where ground communication networks are not available/working.

GPS re-configured in order to provide raw data to **Ground Augmentation (SatNav)**. Navigation signals will be subject to real-time processing to allow **EGNOS-like** monitoring and processing of the estimated position of the drone [**real-time drone position and SBAS (EGNOS) integrity**].

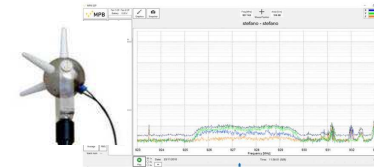
LTE/5G SIM

SEP – sensor for the measurement of the electromagnetic fields

4K / 360° Camera - A real-time **Virtual Reality** environment to display the 360° videos, the measurement of the electro-magnetic field intensity and the drone position integrity information, all of them in a **3D precision environment provided by e-GEOS with**



Thermal Camera and FHD Camera





F2V

F2V – Satellite Role



Satellite Communication

Through the **satellite communication** on drone system we introduce an **additional communication channel able to guarantee a greater security of flight operations** in a **BVLOS** (Beyond Visible Line Of Sight) operational scenario.

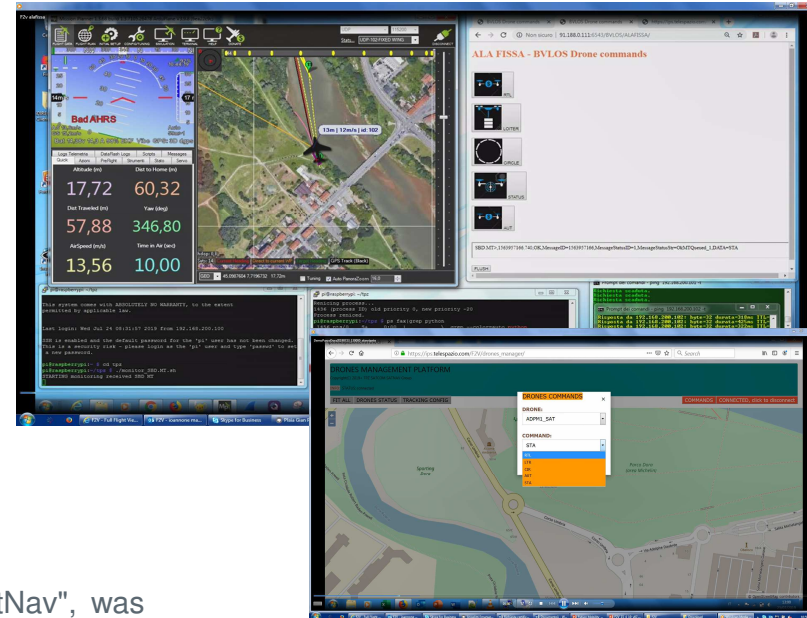
In addition to terrestrial communication systems (Lora, LTE), an **IRIDIUM terminal** is mounted on board the drones (both fixed and rotary-wing) **to guaranteed the transmission of the drone position and the receipt of a predefined set of commands** also where ground communication networks have failed.

Satellite Navigation

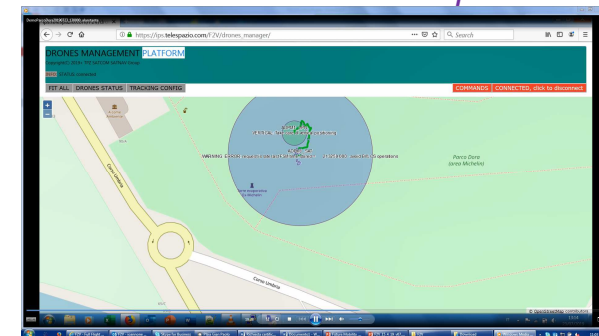
A subsystem of augmentation on the ground, called "SatNav", was implemented in order to make available to the on-board terminal the **GBAS / SBAS (EGNOS) functions**.

A **re-configured GPS receiver** on board is used to transmit the raw data to the SatNav front-end interface for the **drone augmented position and the SBAS integrity real-time processing** .

The SatNav system checks the raw data of the on-board receiver and calculates the limits for position errors and estimates the goodness of the calculated position data while providing indicators of the integrity of the data itself (integrity protection levels).



Web-portal





F2V – Planning and post-processing data

Planning elements

AWARE PLATFORM
For a global knowledge and management of your assets.

Health
Deformations & movements identification by the use of **Satellite interferometric products, GNSS monitoring, IoT technology, RPAS video**

Control
Monitoring the assets and infrastructure changes and activities in the surrounding by the use of specific **Encroachment and Change detection analysis, spatial analysis, RPAS video**, high resolution **cartography** and 3D models to monitor the surrounding area

Operations
Supporting the day by day management with **GIS platform** for continuous data management, integration and analysis

AWARE SUPPORTING DATASET

3D VR DATABASE

Digital Terrain Model (DTM)
Digital representation of ground surface topography or terrain

PRODUCT DESCRIPTION
Reference system
Geographic coordinate system WGS84
Availability
Worldwide basis
Compliance with standards.
Format
GeoTiff, DTED
Spacing
90m, 30m, 10m, 3m
Accuracy
Vertical: 30m, 3m
Horizontal: 5.0 m

Digital Surface Model (DSM)
Digital representation of ground surface topography including buildings, vegetation, and natural terrain features

PRODUCT DESCRIPTION
Category levels
LOD1 (LOD2 - LOD3)
Accuracy
Object height: 2 m
Geo-location : 2 m CE 90
Vertical resolution: 0.1 m
Format
Vector : CityGML, Collada, ESRI SHP 3D
Coverage
As large as chosen by customer
Reference system
Geographic coordinate system WGS84
Availability
Worldwide basis

Post processing products

AWARE RPAS DATA INTEGRATION

Integration of the RPAS payload data and video



F2V

F2V – scenarios & demonstrations (July 2019) (1/2)

Safety with BVLOS

Demonstration of the **remote control** of the drone taking place thanks to the **transmission of the position and of commands through a satellite communication system**. Drones equipped with **Iridium satellite terminals**, which guarantee aircraft control in a **BVLOS operational scenario** where ground communication networks have failed.

Also tested a **Ground Augmentation (SatNav)** system, associated with flight safety and that will make **EGNOS** functionalities available to the onboard terminal providing in **real time the drone augmented position and the SBAS integrity**.

RPAS employed: fixed- and rotary-wing types, MTOW range from 300 g to 9 Kg.



Stura Park (Turin)



Personal safety

Any individual practicing sports in the city parks can, in case of need, draw the attention of a **drone capable of transmitting real-time videos and data to the operation center**. The performance of such operation is completely **automated**, with no pilot intervention.

RPAS employed: rotary-wing type, MTOW less than 300 g.





F2V – scenarios & demonstrations (July 2019) (2/2)

Monitoring and control of the territory

Realization of **the electromagnetic field measurements** with the integration of **the 4k 360 ° camera** acquisitions and the integrity levels values of drone position.

To support an applicative context, mission information with the addition of maps and all data acquired by on board sensors, will be made available by **means of 3D display systems in Virtual Reality (VR) mode**.

In post-processing phase, **integration of the on board data with multi-source and multi-temporal data**, for the reconstruction of architectural and cultural scenarios in a 3D environment in order to implement a procedure for updating the dataset to support the decision-making process (**AWARE** platform).

RPAS employed: rotary-wing type, MTOW less than 9 Kg.



Dora Park (Turin)



Infrastructure monitoring and control

Identification areas and infrastructures with pre-existing deformation phenomena through interferometric analyses in order to support the punctual survey campaigns planning using suitably equipped RPAS platforms (i.e. high-quality photo shoots and thermal TV camera images). The collected on board data will be integrated and be made available through the platform **AWARE**.

RPAS employed: rotary-wing type, MTOW less than 300 g.



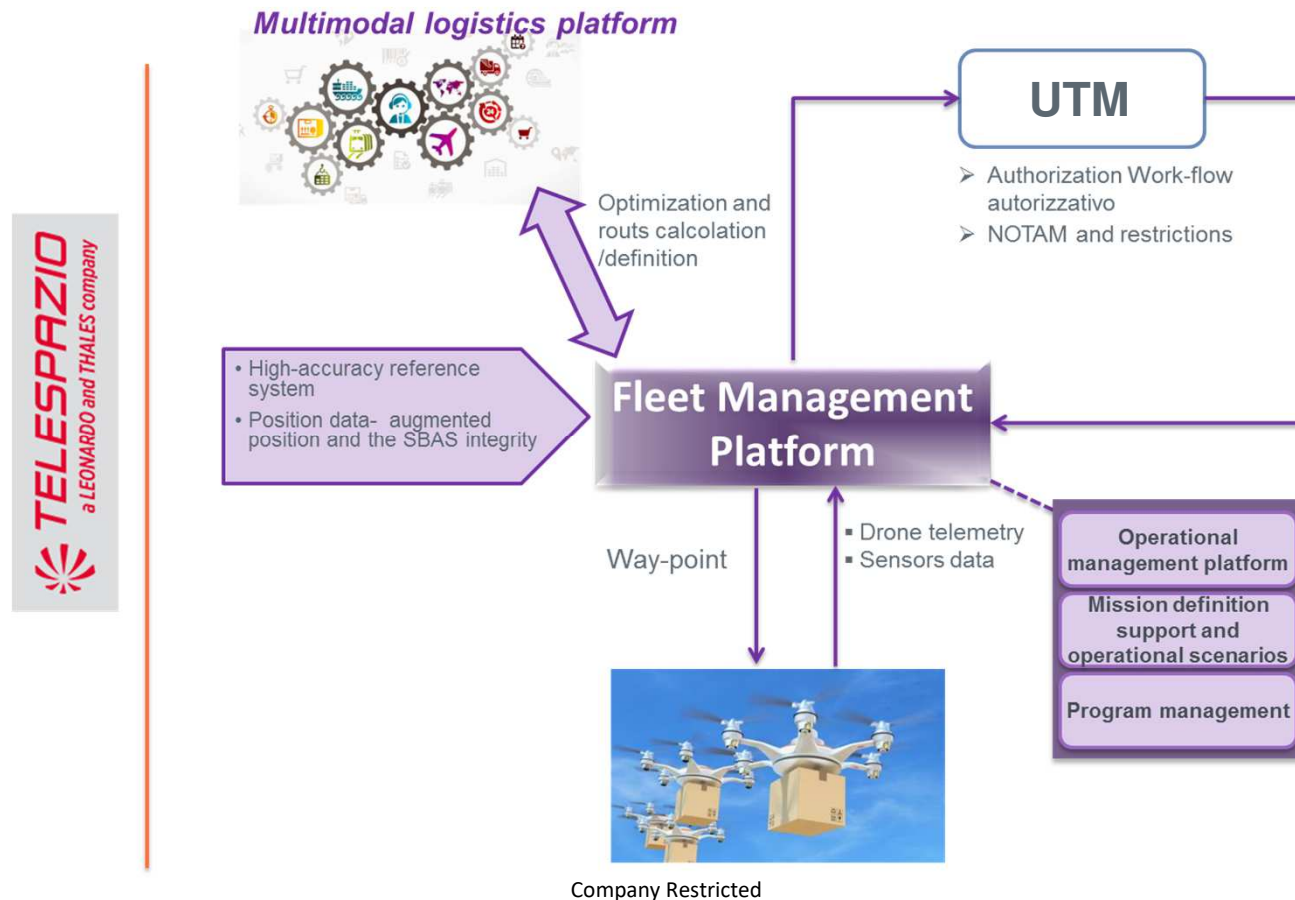
Viaduct SP501 (Turin)





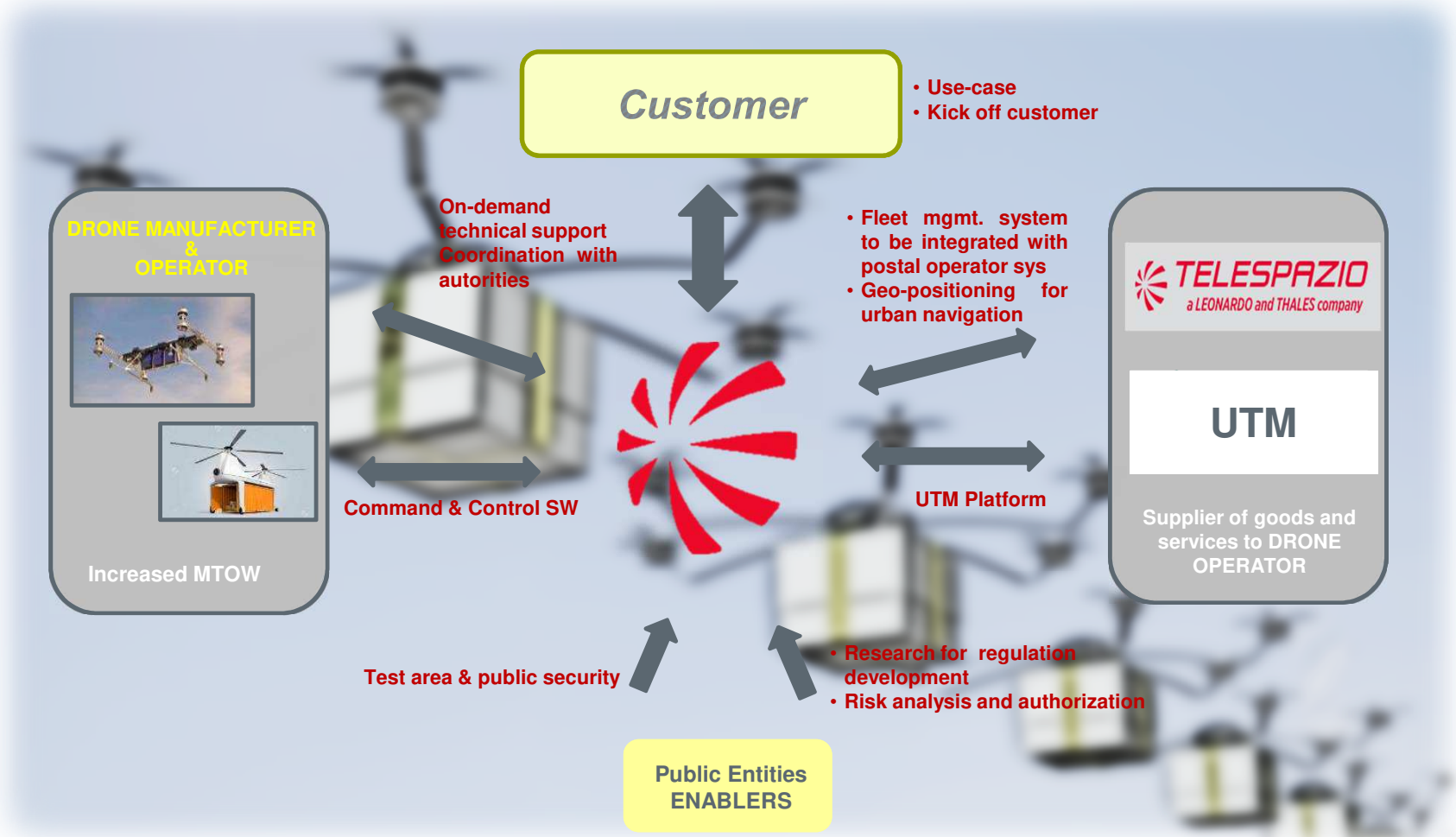
Next step: Urban delivery Service Platform (1/2)

A potential new application is an **urban delivery service** based on **RPAS platforms** for transporting materials from peripheral logistics hubs to city "ports"





Urban delivery Service Platform (2/2)





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THANK **YOU**
FOR YOUR ATTENTION

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