

# Satellite Navigation in Italy: Status and Perspectives



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# Satellite Navigation in Italy:



- **International level:**

- Present in ICG, as single country and as EU MS, to contribute to the international cooperation for a full interoperability of GNSS and SBAS services
- International cooperation with space agencies of third countries (e.g. NASA for GPS and Galileo use on space services)



- **European level (EC and ESA):**

- Participation to the European programme EGNOS and Galileo (definition, development, operations, exploitation, evolution) including ESA and EC/EUSPA national delegates
- Among leading EU countries in term of E-GNSS infrastructures, operations, Public Regulated Service introduction, downstream and application projects for public and commercial sectors
- Second Largest contributor to NAVISP and ARTES BASS (business applications) ESA programme



- **National level:**

- Very active at national level with R&D projects, innovation, SME's and promoting the GNSS integration with other space services (telecommunication and Earth Observation)
- Coordination in place for institutional use of GNSS services for strategic infrastructures and social benefits
- ASI has recently adapted its internal organisation to better address the future needs adding to the Telecommunication and Navigation Unit other complementary units (e.g. Downstream and applications, European relations, Space Economy)

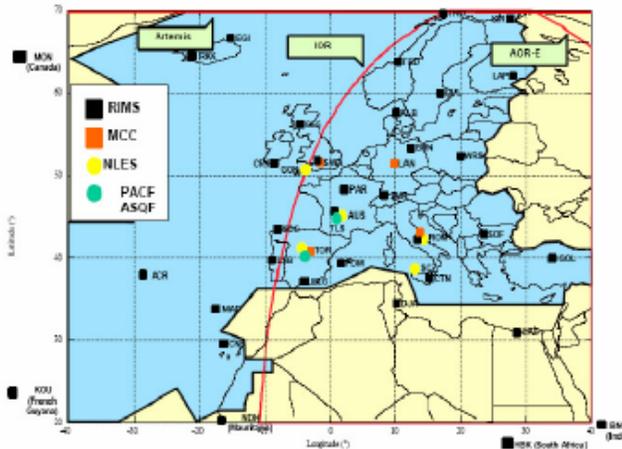
# E-GNSS infrastructures and services in Italy

GALILEO

Major Galileo centres and facilities are located throughout Europe



EGNOS



EGNOS sites in Italy:

- Mission control Center MCC (Ciampino/Rome)
- Uplink GEO station (Fucino)
- Reference Stations RIMS (Rome and Catania)

- Italy host many facilities and major centres of Galileo and EGNOS (E-GNSS)
- All the main Italian space companies involved on E-GNSS (system, ground, user segment)
- National facilities are supporting geodesy and timing services for Galileo (Turin and Matera)
- Dedicated national optical fibre network connects all facilities
- The National geodetic GNSS network has been upgraded to GPS and Galileo

# GNSS for Drones (UAV/UAS/RPAS)



National GNSS/Drone programs include:

- Definition and development of prototypical applications for light drones (<150 kg) at low altitude (<150 meters), using EGNOS and Galileo services for the benefit of UTM (UAS Traffic Management) (ongoing);
- Upgrading of heavy RPAS/UAS with EGNSS and other sensors to fit Air Traffic Management (ATM) regulations of EASA and ENAC (in progress);
- GNSS Service Monitoring for RPAS applications to improve resilience and safety when used in ATM (in progress);
- Research and development of integrated satellite systems to manage and monitor small airports/vertiports/heliports and study of the relevant operational concept (planned).

# GNSS for Railway

Development of multimodal augmentation and integrity architectures, prototypes, receiver (also on-board) and railway applications, based on EGNSS and SATCOM for satellite train control on local/regional lines and for the support to the introduction of satellite control system in the European ERTM/ETCS.

These programs will include in particular:

- Automatic Train Protection: introduction of GNSS in the European standard ERTMS/ETCS with virtual radio beacons with a view to reduce OPEX/CAPEX costs;
- Automatic Train Protection: Introduction of GNSS for regional lines (48% of Italian network) to implement ERTMS/ETCS regional at level L3;
- Automatic Train Control : Implementation of Check of integrity and length of trains;
- Automatic Train Operations: Automatic operations for for trains, subways and tramways.
- Train-RAIM: Prototyping of RAIM equipped on-board receiver to implement Fault Detection and exclusion of outliers and computation of protection levels (in progress).

RFI and ASI are working for the first Virtual balise ERTMS certified rail lines foreseen in Italy (Novara-Rho line)

Roy Hill Project ATP L3, Australia

Rio Tinto Auto Haul ATO L2



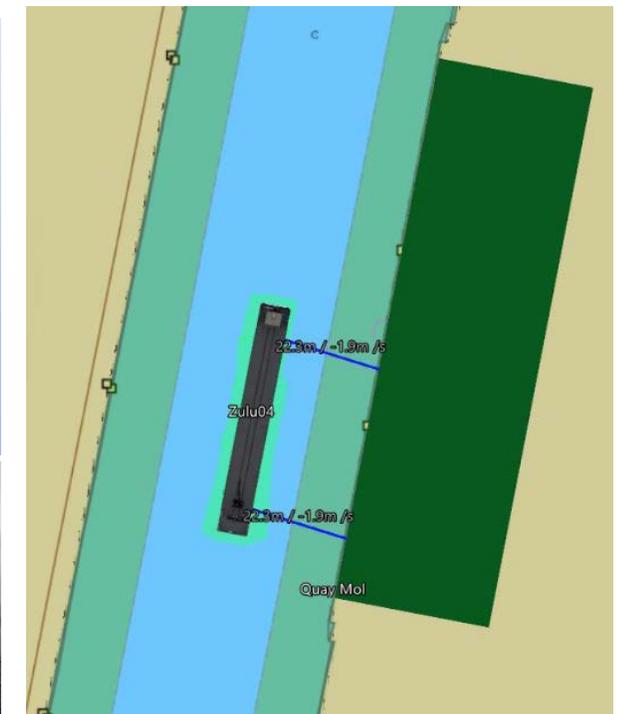
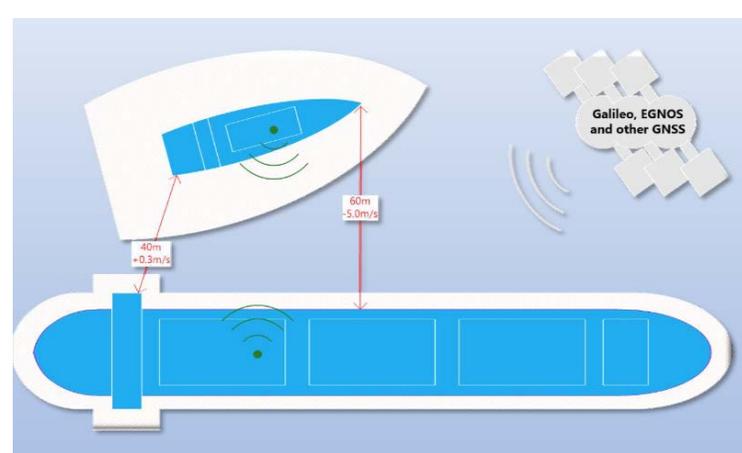
# GNSS on Maritime

- Development of maritime application/services based on GNSS with a view to manage the access to the harbour in compliance with IMO accuracy stipulated by IMO resolution A.915(22)] (in progress);

-In the framework of e-navigation di IMO, development of autonomous navigation and docking using multi-system receivers and augmentation system capitalizing VDES [planned];

-Introduction of RAIM techniques for SOLAS vessels for checking on-board consistency of measurements according to IMO A.915 (22), in combination with in-space signal integrity alarms. [planned]

-cooperative maritime PNT. V2V position communication to ensure safe distance between boats in proximity (to be planned).



# GNSS for road and autonomous vehicles

-Research and development of methodologies for the localization of vehicles through the integration of satellite technologies, wireless connectivity and sensors on board (in progress, agreement between ASI and the University of L'Aquila).

-Implementation of SAE automation levels starting from L3 in the field of road transport with the integration of satellite location (planned);

Development of artificial intelligence algorithms (e.g. deep learning) to support localization in autonomous driving applications (e.g. for the absolute space-time position, able to avoid obstacles, etc.) and with cybersecurity features (planned);

-Developments of Integrated Sensor Systems on board of autonomous and connected car involving GNSS (planned);

- Realization of a Test-bed to validate the previous ongoing developments based on a collaborative network of competence centres, laboratories and national certification bodies (to be planned)



EZ10 (2015) uno dei primi bus autonomi



**ZERO**  
CRASHES

**ZERO**  
EMISSIONS

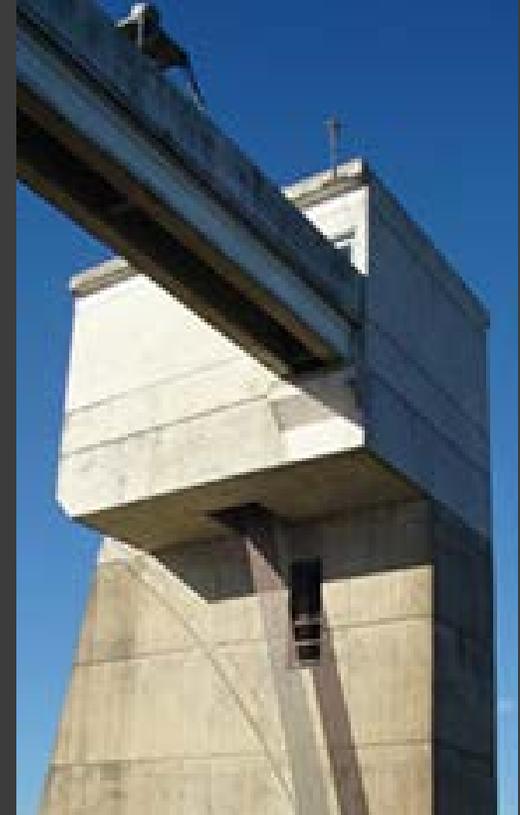
**ZERO**  
CONGESTION

# Space integrated applications

The development of following programs based on integrated applications of TLC/NAV and EO technologies are on-going:

- COORDINATE. Cooperative localization of the automotive in complex urban scenarios (in the presence of interference, multipath and masking, cyber attacks ...) taking advantage of the rapid evolution of the IoT and the 5G network, with the experimentation of the approach of distributed Receivers-of-Opportunity (RoO) .
- PEDROS. Use of UaVs in the prevention of environmental crimes by testing a remote piloting system, with definition of the flight path in automation and with real-time recognition of areas of vegetation damaged and/ or affected by fires, assisted by airborne sensor and satellite system.

Further integrated applications will deal with assets health monitoring in conjunction with remote sensing interferometry and precision farming.

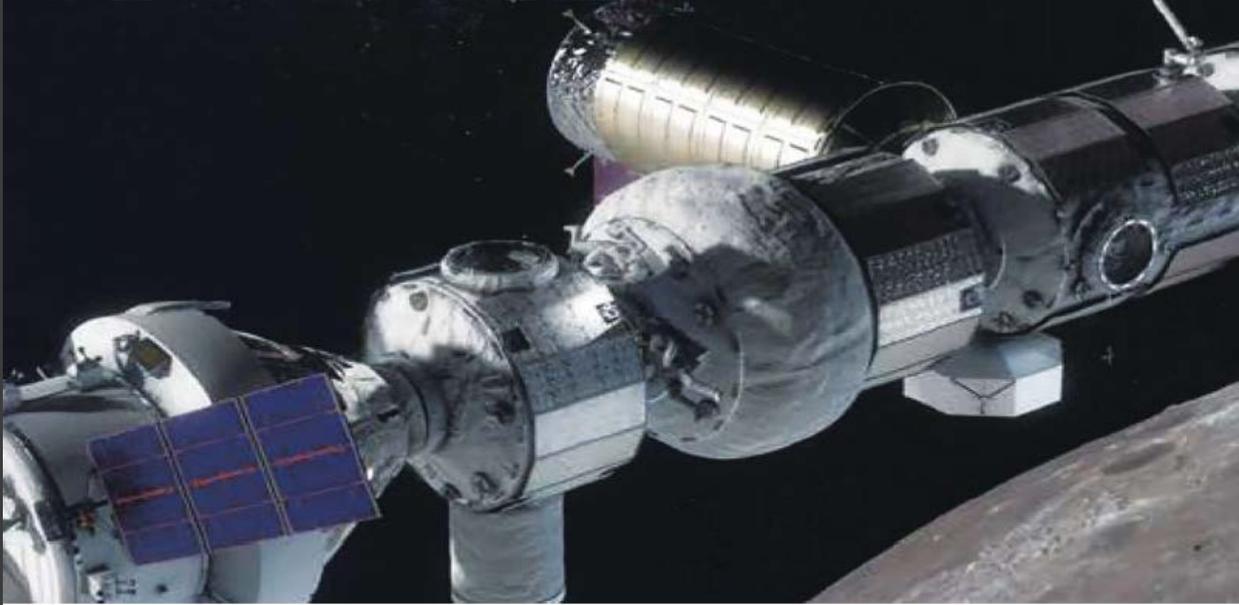
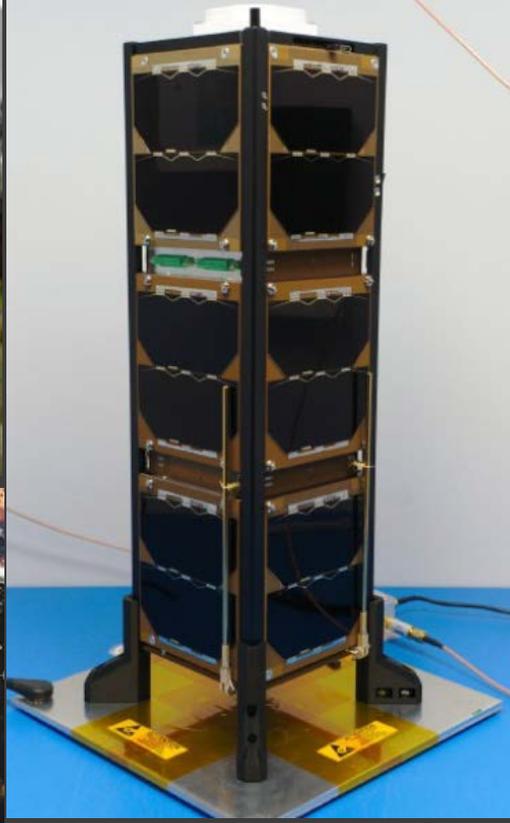


# Research & Development

The following R&D programs are currently on-going thanks to SMEs, universities and research institutes for developments in the field of navigation [TRL $\leq$  4]:

- ✓ CELESTE: Autonomous navigation of satellites in lunar orbit;
- ✓ SMARTGO: Safe navigation of drones in challenging environments;
- ✓ ARES4SC: Navigations for constellation of satellites orbiting Mars or other celestial bodies based on Inter-Satellite Link;
- ✓ DEEP-NAV: Optical Navigation on asteroids;
- ✓ AVERIG: Development of a new generation ASIC based GNSS receiver;
- ✓ ABACO: New Precise Orbit Determination for autonomous satellites navigation;
- ✓ NIM: Development of autonomous navigation system for nanosatellites
- ✓ ANHEO: Development of an ihybridized navigation unit for microsatellites in terrestrial or lunar orbit.

Starting from 2023, one of these projects could be selected to continue development up to higher TRL.



# Future Research and Development

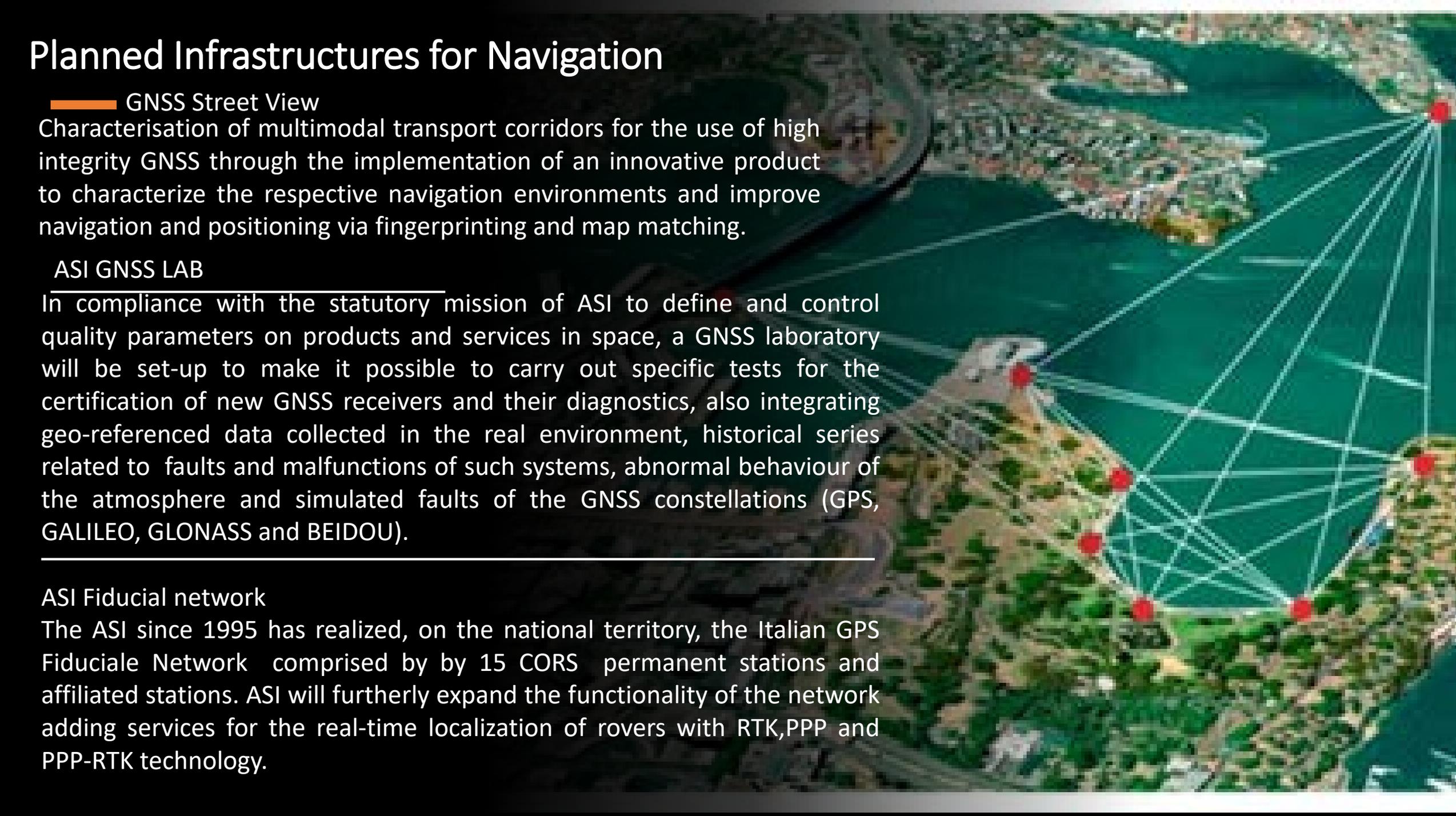
- ASI will follow the recommendations contained in the white paper issued by the EUSPA/GSA for the areas of interest and innovation for research in the EGNSS (Recommendations for areas of focus and innovation funding for EGNSS R&D-White paper) of 2019.
- The transversal requirements to be considered are: high precision and integrity, multipath mitigation; reduced energy consumption; reduced acquisition times and Time To First Fix; improved antenna level performance, hybridization and fusion sensors.

These areas of research are planned with two steps approach:

- Step 1: Basic research and development activities in PNT related to the implementation in the laboratory of architectures, processing techniques and algorithms for the reception of GNSS signal of an innovative type [TRL <= 4].
- Step 2: Based on the results of the previous step 1, the activity will be brought to an higher TRL with the realization of technological demonstrators of GNSS receivers to be tested in relevant real environment.



# Planned Infrastructures for Navigation



## — GNSS Street View

Characterisation of multimodal transport corridors for the use of high integrity GNSS through the implementation of an innovative product to characterize the respective navigation environments and improve navigation and positioning via fingerprinting and map matching.

## ASI GNSS LAB

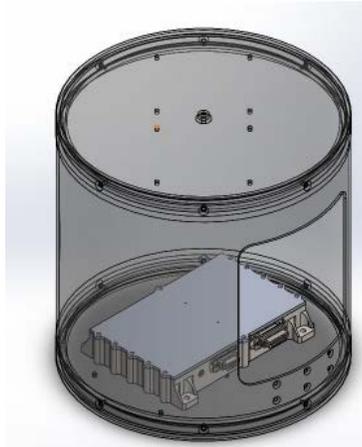
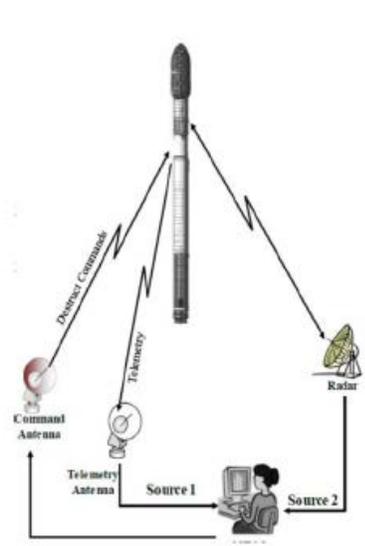
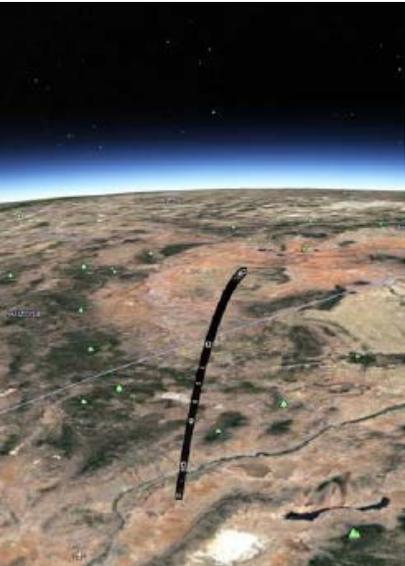
In compliance with the statutory mission of ASI to define and control quality parameters on products and services in space, a GNSS laboratory will be set-up to make it possible to carry out specific tests for the certification of new GNSS receivers and their diagnostics, also integrating geo-referenced data collected in the real environment, historical series related to faults and malfunctions of such systems, abnormal behaviour of the atmosphere and simulated faults of the GNSS constellations (GPS, GALILEO, GLONASS and BEIDOU).

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## ASI Fiducial network

The ASI since 1995 has realized, on the national territory, the Italian GPS Fiduciale Network comprised by 15 CORS permanent stations and affiliated stations. ASI will furtherly expand the functionality of the network adding services for the real-time localization of rovers with RTK, PPP and PPP-RTK technology.

# GNSS for space sector (launchers, satellites, Moon mission)



## GNSS for rockets (ASI/NASA/ESA):

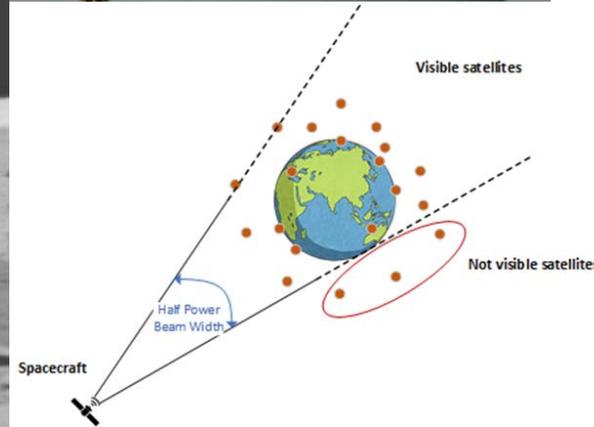
- 22/11/19: First Sounding rocket launched (Spaceport America in New Mexico /USA) has demonstrated the very good performances of an Italian GNSS Receiver using GPS L1 and Galileo E1 signals under a highly dynamic environment.
- March 2022: a Second flight is planned with the upgraded GNSS receiver fully integrated on the on-board avionics as part of the Autonomous Flight Termination System (AFTS)

## NASA/ASI ARTEMIS study agreement

- ASI is contributing with telecommunication and navigation concepts and ideas for the future Moon Gateway and Surface infrastructures tasks

## Cis-lunar and Moon surface GNSS (NASA/ASI/Qascom):

- As part of the ARTEMIS ASI/NASA cooperation, a first experimental mission shall embark, on a FireFly Lander, the ASI/Qascom state-of-art GPS/Galileo dual-frequency receiver (Lunar GNSS Receiver Experiment LuGRE) aimed to characterize the GNSS signals and service on transit orbit and lunar surface for 14 days. This will be the first GNSS fix on the Moon in 2023!





Agenzia Spaziale Italiana

A satellite view of Earth at night, showing the illuminated landmasses of Europe and Africa against the dark background of space. The lights from cities and towns are visible across the continents.

**Thank you for attendance**