



The role of the PNT Ecosystem in the Italian Space Strategy

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Agenzia Spaziale Italiana

Italian Space Governance

President of the Council of Ministers (or his delegate):

- senior management, overall political responsibility and coordination of national policies relating to space and aerospace programmes
- presides over COMINT

COMINT (Interministerial Committee for Space and Aerospace):

- sets the Government's directions in space and aerospace matters
- **Military Advisor to the President of Council' Office** provides secretariat to COMINT

ASI (Agenzia Spaziale Italiana):

- provides technical-scientific support to COMINT
- consistently with the Government guidelines, it prepares the national political strategy document on space and the Strategic Vision document which is approved within COMINT



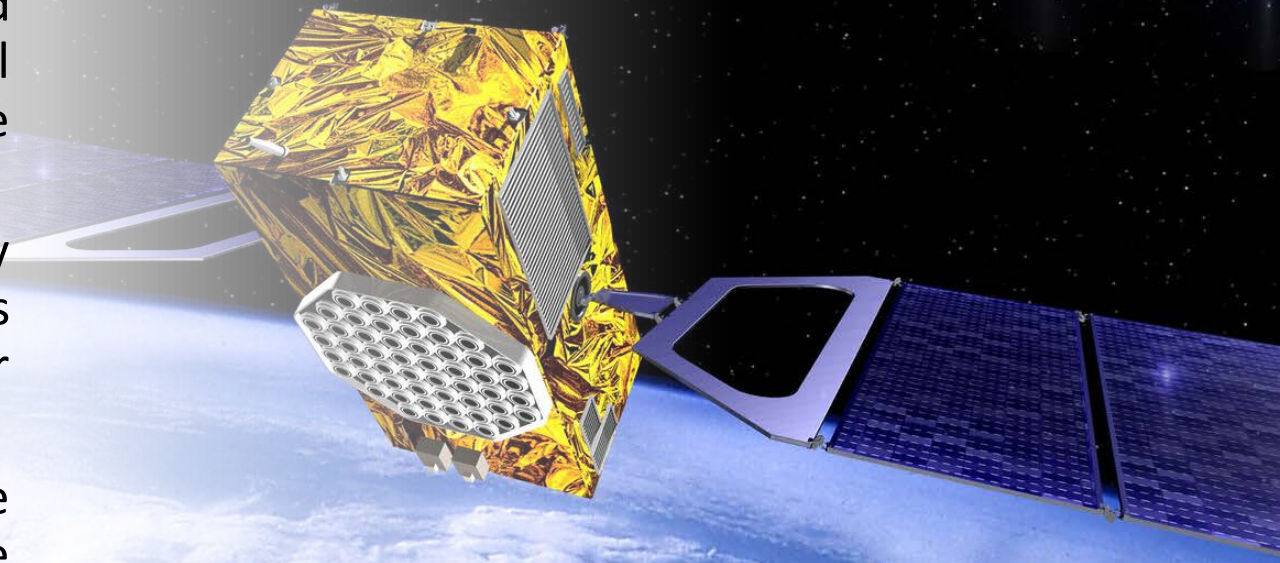
UPSA - Office for Space and Aerospace Policy:

- established at the Presidency of Ministers provides support to the political authority in the exercise of its functions

Objectives of Navigation in Italy

- Realization of projects to support the development of systems and applications of satellite radio-localization in fields such as transport (rail, maritime, automotive and aviation), mass-market services (Location Based Services), protection of the territory and critical infrastructure, sustainable and circular agriculture (precision farming), geodesy and remote sensing.
- Support the competitiveness of the national supply chain for the development of emerging technologies based on the integration of GNSS with other technologies, including non-space ones.
- Development of innovative applications of satellite radio-localization to be used by the citizen and the public administration boosting the economic and cultural development of the country.

The Italian Navigation activities are described in the three-year plan (Piano Triennale 2022-2024) of Italian Space Agency under the chapter «Programma di Navigazione Satellitare».



Italy participation to ESA optional programmes on Navigation



Italy participates to all the European Space Agency optional programmes in the navigation domains:

- NAVISP (Navigation Innovation and Support Programme, programme for technological and application R&D)
- GENESIS (mission aiming at improving and homogenizing time and space references)
- LEO PNT (in-orbit innovative LEO PNT technologies and potential services)

Italy is the largest contributor in total to ESA NAV optional programme (ESA Ministerial Council 2022 subscription)

Navisp programme: opportunity for Italy



Italy suscription to NAVISP Phase 3 at C-Min 2022:

NAVISP Element 1 M€ 6.00

NAVISP Element 2 M€ 9.00

NAVISP Element 3 M€ 5.00

Total M€ 20.00 (ec 22)

NAVISP General: ESA technical excellence, opportunity to complement national strategy

Element 1: ESA workplan inspiring content, timely procedures

Element 2: permanently open opportunity, smooth co-funding

Element 3: permanent open opportunity, ESA for European dimension

Italian GNSS Competence Centre

- ASI is currently coordinating the development of GNSS infrastructures and system deemed to be the technological enablers for applications of interest for the public.

- The current activities are described in the following slides.

National GNSS Competence Centre

- In compliance with the statutory mission of the Agency, which prescribes to define and control the quality parameters on products and services in space, the ASI intends to equip itself with a center of competences of the Navigation that will allow to realize specific test bed for the purpose of certification of new receivers and technology GNSS and their diagnostics.
- The center will contain laboratory instrumentation and a complete development and testing environment (with modelling-and-simulation capabilities) to test new receivers and navigation algorithms in both HWIL and SWIL mode, capitalizing the results of the various development programs already concluded by ASI and using the digital twin environments.
- The centre will also serve as a repository for all products and equipment produced by Navigation programs of ASI, as well as a center for processing data acquired by the various missions of Navigation.



CNCG

Centro Nazionale Competenze GNSS



Agenzia Spaziale Italiana

Infrastructures for navigation

National augmentation network

- In order to ensure a modern and safe mobility for Italy, it is necessary a national infrastructure that provides a navigation service (PVT) with increased accuracy in real time, high availability and with guarantee of integrity that can be used by the user to drive high automation transport systems.
- In this context, ASI intends to realize a state-of-the-art solution regarding the systems of Augmentation, having as objective the mobility of the future.
- The first instance of the experiment will consider the deployment of a limited set of stations along a railway and road/motorway route in support of connected vehicles and smart roads and with, also, the aim of facilitating the adaptation of the railway service ERTMS/ETCS of satellite positioning.





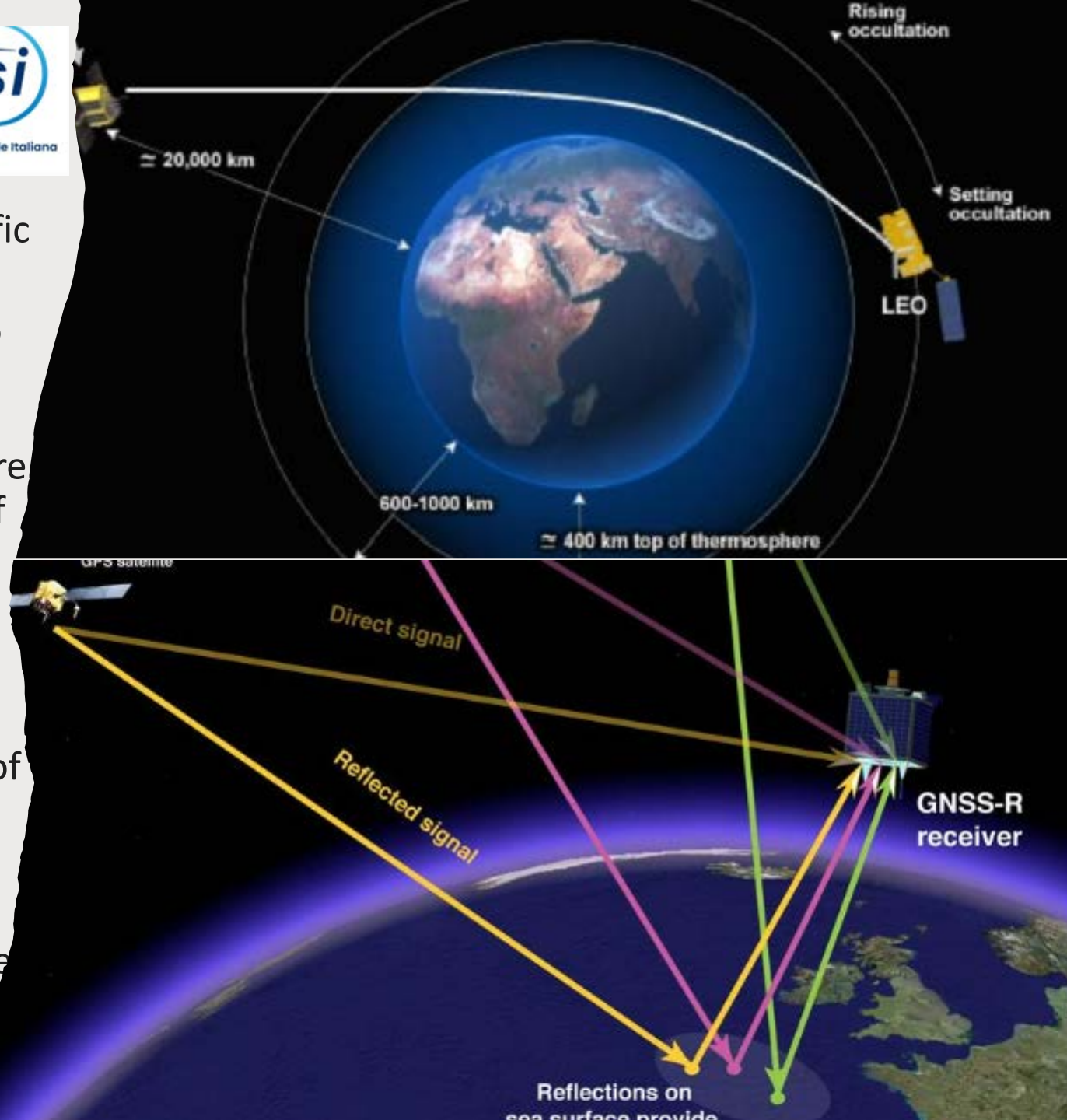
Infrastructures for navigation

- **Dedicated metropolitan beacon navigation system**
- Considering the difficulty of positioning in the urban environment, a supporting infrastructure is needed that strengthens the reception of the GNSS service through the implementation of a Metropolitan Beacon System (MBS) totally transparent to the user in overlap with the satellite GNSS, so as to ensure optimal reception thanks to increased power compared to the satellite signal.
- ASI intends to create a first example in Italy of such a system to be deployed in the urban environment for demonstration purposes and in compliance with 3GPP and OMA standards of mobile telephony.
- This system will also be used in operating theatres such as alternative PNT (A-PNT) where the satellite signal is denied or degraded.

GNSS Radio Occultation and Reflectometry

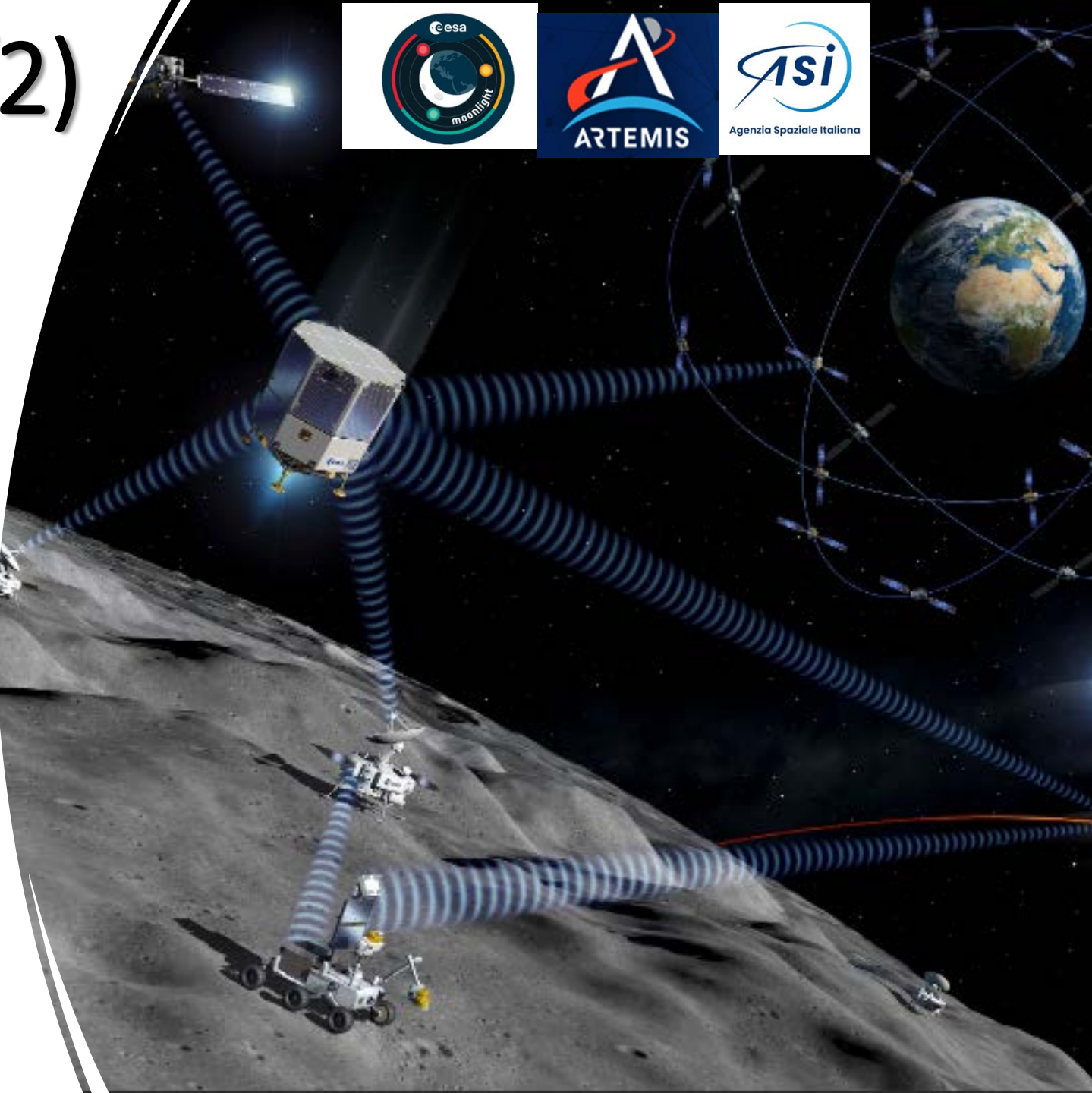


- ASI promotes two innovative airborne GNSS scientific missions of Radio Occultation and Reflectometry.
- These techniques have the advantage, compared to traditional radar or radiometer sensors, of having a better temporal and spatial resolution thanks to the abundance of GNSS signals, using those effects that are normally considered harmful for precise calculation of PVT, such as ionic-tropospheric delays or multipath.
- The activities include the realization of the two instruments GNSS-RO and GNSS-R, for the acquisition of the raw data, the processing of the acquired data and the correlation with the geophysical parameters of interest (atmospheric, biomass, surface humidity) for the climate study, weather forecast and precision agriculture applications.
- Research and development activities will be validated with aerial platform field testing and the results will be used as a precursor for dedicated satellite missions.



Lunar activities (1/2)

- **Motivation.** After 50 years since the first Apollo 11 mission, now the interest in coming back to the Moon has increased to high level worldwide and numerous missions are under way. Italy and the other European country share this goal.
- **Our vision is that this time we go the Moon to stay, to build a stable base and use this mission as benchmark for further and farther exploration missions such as Mars.**
- **Plan of action.** The Lunar mission is managed by ESA and coordinated with Italy and other European member states. We follow a step-wise approach, i.e. a first preliminary mission (Lunar Pathfinder) to test the extension of SSV up to lunar orbit and low data rate communications, followed by the full mission (Moonlight) to build the infrastructure.
- At the same time Italy is contributing to the Nasa Artemis mission via the Lugre experiment.



Lunar activities 2/2

- **Strategic objectives.** Italy has contributed to shape that the Moonlight program around the following strategic pillars:
 - Olistic approach. Telecom and navigation mixed asset, full mission profile (orbit, ascent/discent, landing and rover movement), full infrastructure (earth ground segment, space segment, moon ground segment, user segment)
 - Preparation of downstream. The infrastructure will be used to implement the Lunar economy and the moon companies are requested to contribute to the capital investment (20%) along with public funding
 - International cooperation. ESA, NASA and JAXA are preparing the joint Lunanet standar for SIS, geodetic and time reference frames as a basis for the future interoperable mission and as a facilitator for the services adoption.



Conclusions (1/2)



- ASI is building up a national centre of excellence networked with Italian academia to collect the results of national navigation programs, test equipments and algorithms and it is ready to liaise with other similar centres (CCG- Centro di Competenze GNSS, Centre for GNSS Competences).
- Applications of interest for the public are of paramount importance for ASI, so we are currently focusing on the downstream activities leveraging GNSS, satellite telecommunications and remote sensing at the same and targeting fields such as Smart Cities, Precision Farming, Intelligent Transportation Systems (ITS) and Structural Health Monitoring (SHM).
- The potential vulnerability of GNSS is a well-known problem. ASI will push forward its activities on the Galileo Public Regulated Service, which holds great robustness either in a self-contained version or in the PNT-as-a-service fashion (PRS-like).



Conclusions (2/2)



- Asi is investing and supporting the international programs Artemis and Moonlight to deliver safe and sustainable services on the lunar surface. Interoperability and international cooperation is key to the success.
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- LEO PNT and APNT (Alternative PNT) technologies represent the exciting future of radionavigation-based technologies for PNT and ASI is fully committed in the support of ESA LEO PNT programme and realizing the Italian metropolitan urban beacon to augment GNSS service.
 - To protect the environment, monitor the climate change and the space weather, Asi has started two scientific programs devoted to airborne GNSS-R and GNSS-RO, which will be stepping-stone towards spatial-grade equipment in dedicated or piggybacked future satellite missions to monitor the earth, atmosphere and space weather.



Future activities



- Autonomous Navigation will transform our lives in the future.
- ASI intends to focus in the near future on ~~automated vehicles tackling~~ with what are the remaining challenges that hold back autonomous/automatic vehicles [self-driving cars, ASV and GNSS localization powered trains] from general adoption.
- Considering the challenging, denied and obstructed urban of ground/marine environment, cutting edge technologies will be explored such as Machine Learning/Deep Learning, Visual Navigation (VINS, SLAM..) and non-linear filtering (sigma point, FGO..).

Thanks for attention

