

# LEO-PNT IoD and next phase: Industrialisation and In-Orbit Validation

**NIN/NVR Workshop on LEO-PNT**  
5 February, 2025 | NLR, Amsterdam

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# Background – Multi-layer System of Systems



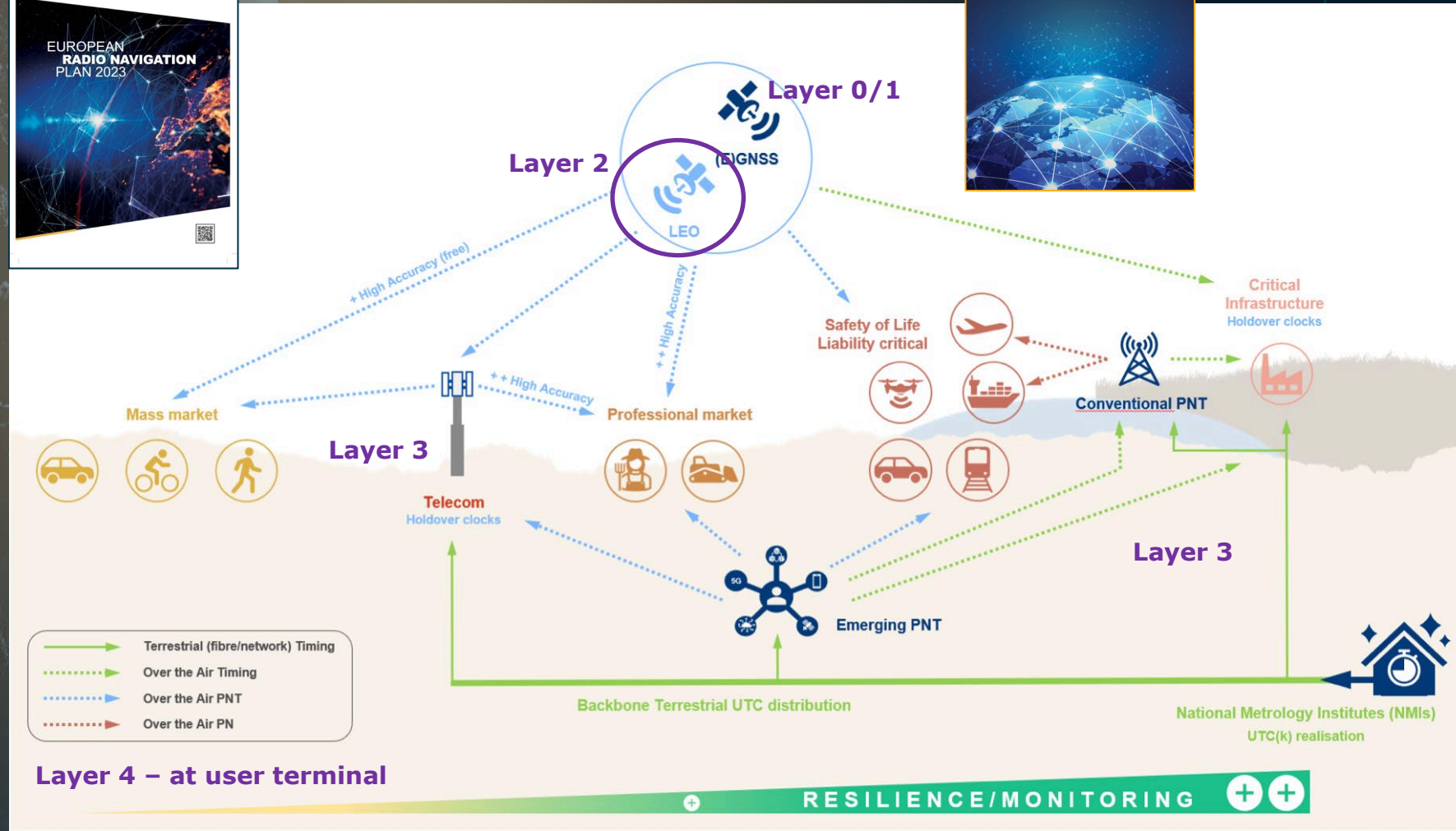
**Layer 0/1 – MEO/IGSO/GEO Backbone**

**Layer 2 – LEO-PNT**  
Resilience and Robustness  
Diversity / Proliferation

**Layer 3 – Local/regional terrestrial components** e.g. 5G PNT, WLAN

**Layer 4 – Inertial sensors / Dead-reckoning**

**LEO-PNT fully complementary & boosting MEO GNSS backbone**



*Future GNSS will be multilayer with IGSO, LEO, MEO and GEO constellations (layers)*





# LEO-PNT International Initiatives

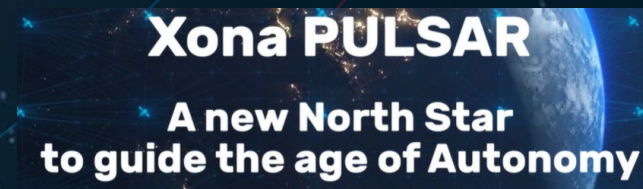
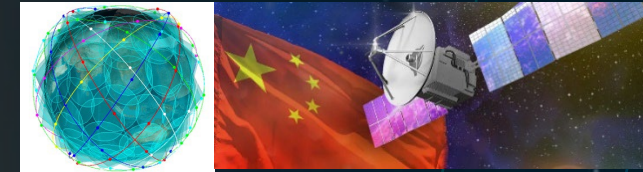


## Several initiatives worldwide for LEO-PNT:

- Europe, China, US, Japan, UAE, Russia, S. Korea, Turkey

## United Nations International Committee on GNSS (UN-ICG):

- LEO-PNT continues to be a **worldwide trend** being one of the emerging topics of most interest by international providers.
- A regular annual LEO-PNT workshop has been established with the objective to discuss and develop a reference standard for **LEO-PNT interoperability and compatibility**.
- **Commercial opportunities** arising worldwide





# LEO-PNT – main strategic pillars



## Pillar I

### Resilience and Robustness

#### RESILIENT AND ROBUST PNT

User level vs Jamming and Spoofing

Different types of users  
(critical infra. / professional / mass-market / ...)

New frequencies (C / S / FusedPNT)



## Pillar II

### Galileo/EGNOS Augmentation

PPP Fast Convergence  
Urban Performance  
NAV Data dissemination

#### GALILEO / EGNOS SYSTEM

GSS in space / Integrity monitoring / Connectivity with MEO via (O)ISL



## Pillar III

### New Service Capabilities

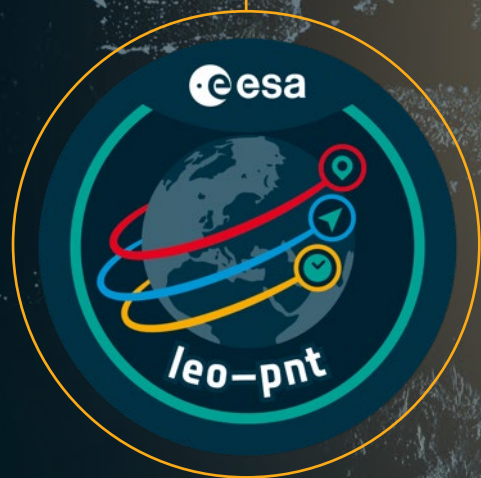
#### S-BD 2WAY 6G NTN PNT

PNT for Personal Emergency and Public Safety  
Low Energy PNT for IoT

#### UHF/VHF PNT

Indoor timing / positioning  
Positioning under heavy shadowed areas





# European LEO-PNT initiative: In Orbit Demonstrator

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# ESA's LEO-PNT In-Orbit Demonstrator



Develop enabling technologies



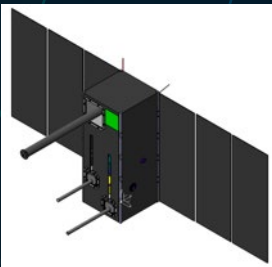
Demonstrate services



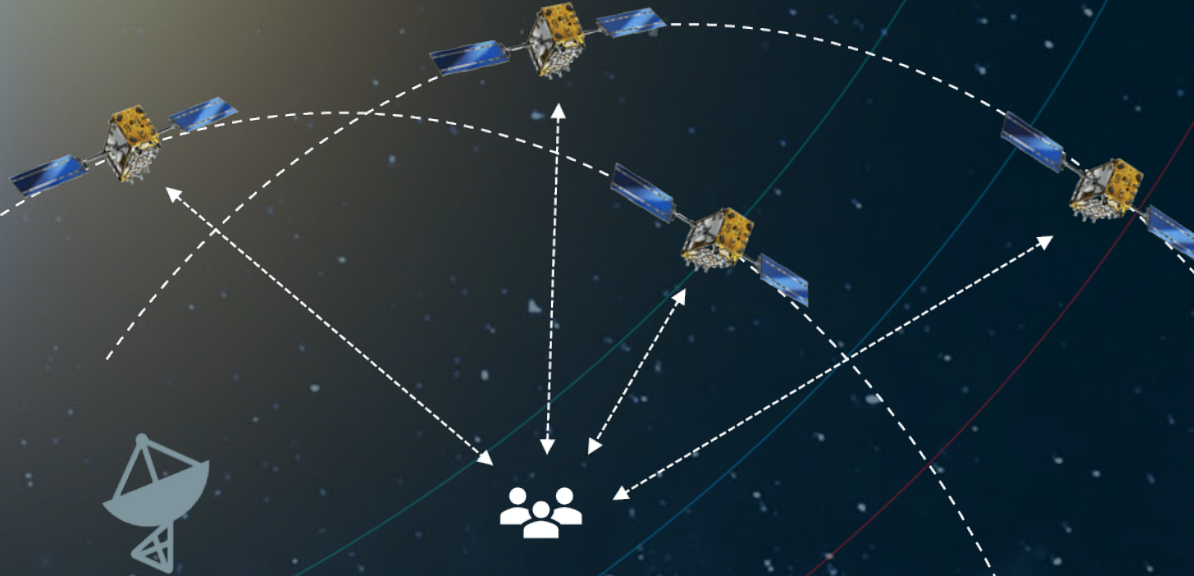
De-risk adoption - standards, regulatory, ...



Part of ESA's FutureNAV programme



Accelerate LEO-PNT from concept to demonstration through a fast-track **in-orbit demonstration** and prepare **added-value services** for potential future operational LEO-PNT systems.



# LEO-PNT In Orbit Demonstrator – Industrial Contracts



## 2 parallel contracts:

mini-constellation deployment : 2025 - 2027

Each includes:

- system and space segment
- launch services
- ground segment & operations
- test user segment
- experimentation and service demonstration
- (involvement of end-users)

### 1 Pathfinder A satellite

- Launch ready by end 2025.
- Quasi-polar orbit at ~550 km
- PNT signals in L and S bands
- De-risking and 1-SV experiments.
- 12-month lifetime

### 4 Pathfinder B satellites

- Launch ready by end 2026.
- Quasi-polar orbits at ~550 km
- PNT signals in L, S, UHF, C bands + 2 way.
- Service demonstration (4-SV experiments)
- 16-month lifetime



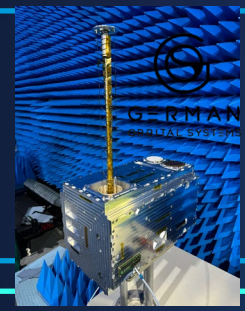
Platform by Alén Space  
12U Cubesat



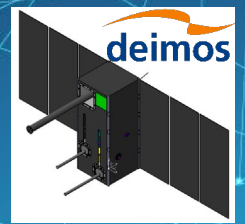
Platform by OHB  
<100 kg microsat



Platform by GOS  
16U Cubesat-like



Platform by Deimos  
<100 kg microsat

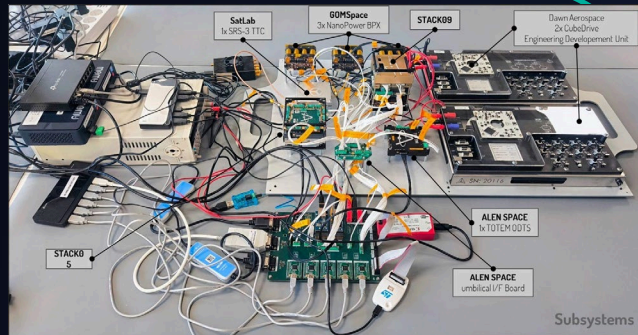


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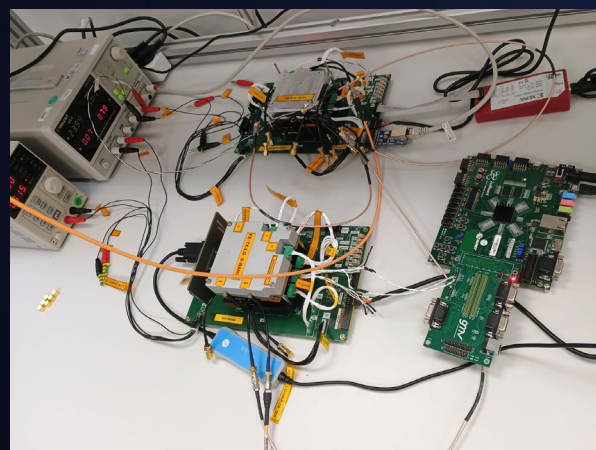




# LEO-PNT In Orbit Demonstrator – Pathfinder A EMs

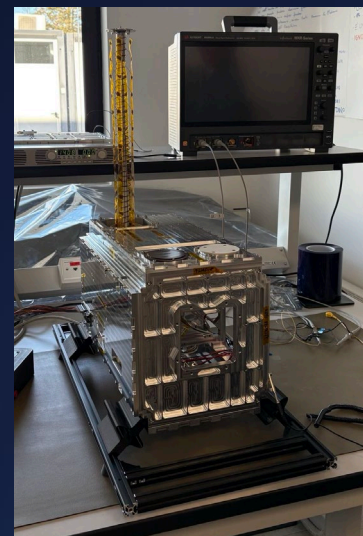


Platform flatsat

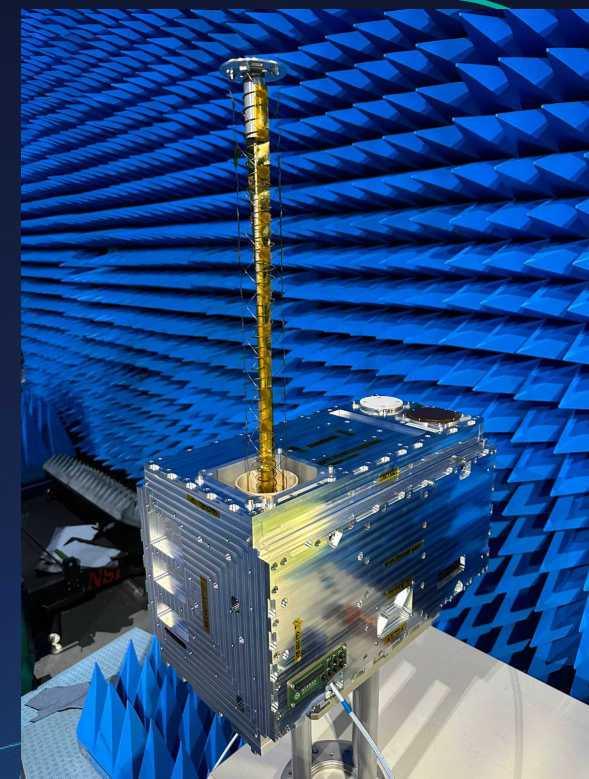


Flatsat – Payload EM units

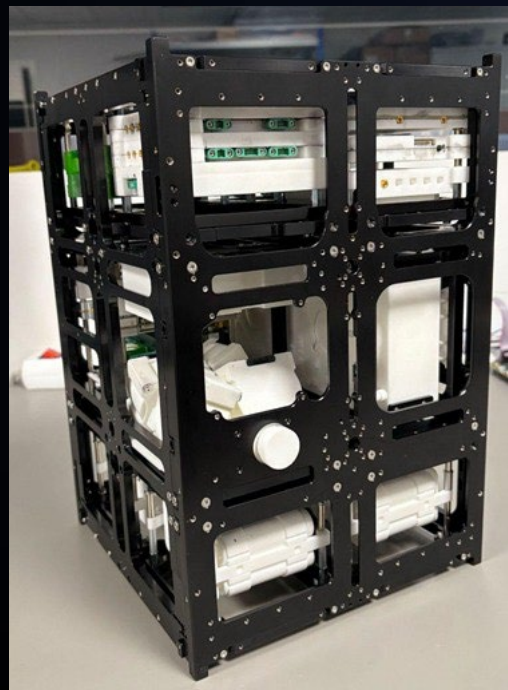
ThalesAlenia  
a Thales / Leonardo company Space



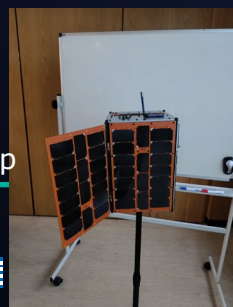
EM platform



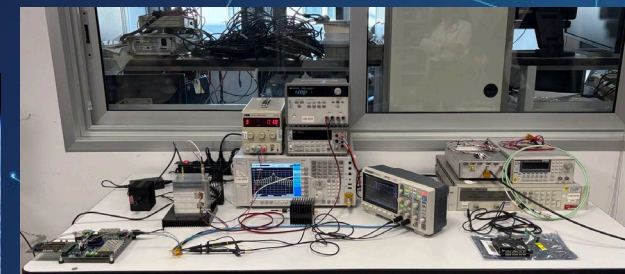
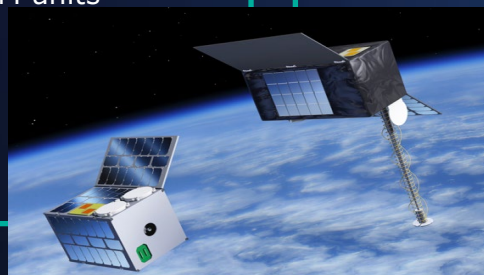
EM satellite Payload radiated tests



Platform SM



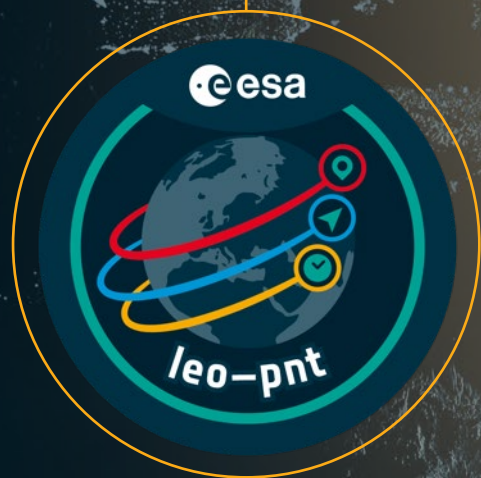
Satellite mock-up



Flatsat – Payload EM units







# Future activities

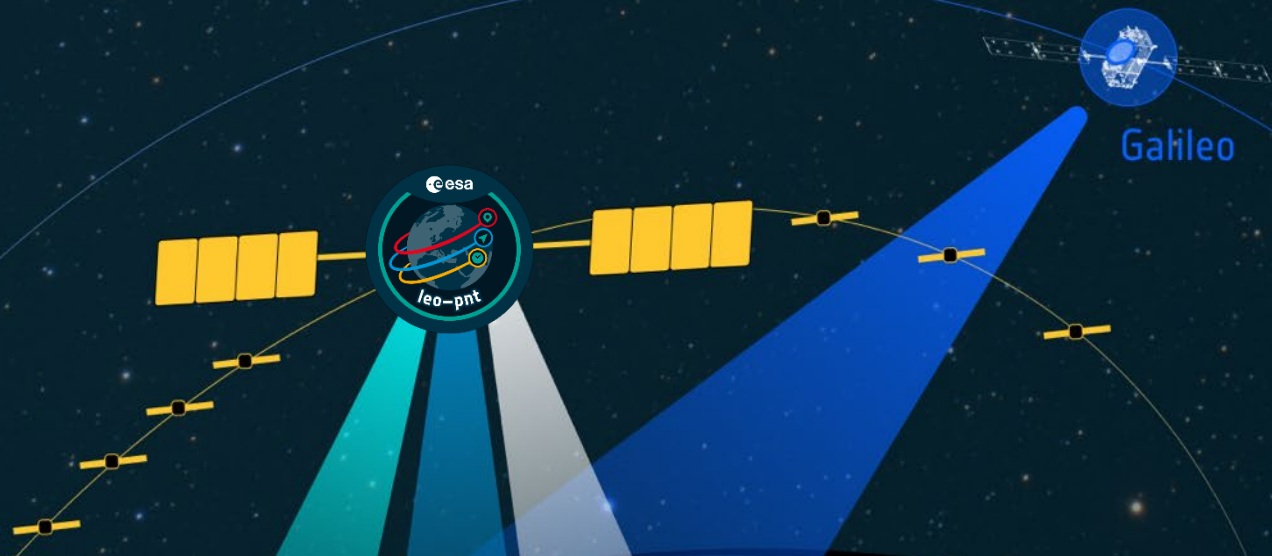
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# LEO-PNT next phase: Industrialisation and In-Orbit Validation

... from prototyping / demonstration to industrialisation / in-orbit validation

- **Industrialisation and In-Orbit validation phase** towards an EU Institutional operational system and also supporting Commercial initiatives.



**Galileo/EGNOS  
Augmentation**

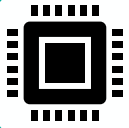
**Resilience &  
Robustness**



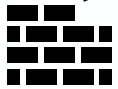
**New service capabilities  
(6G NTN, Indoor PNT, IOT)**



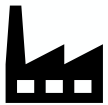




Mature the enabling technologies for building blocks (e.g. advanced on-board receivers, miniaturised clocks, antennas).



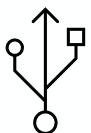
Development, qualification and validation of Building Blocks



Industrialisation of building blocks in order to develop manufacturing and integration capabilities, allowing to boost production rates and decrease cost.



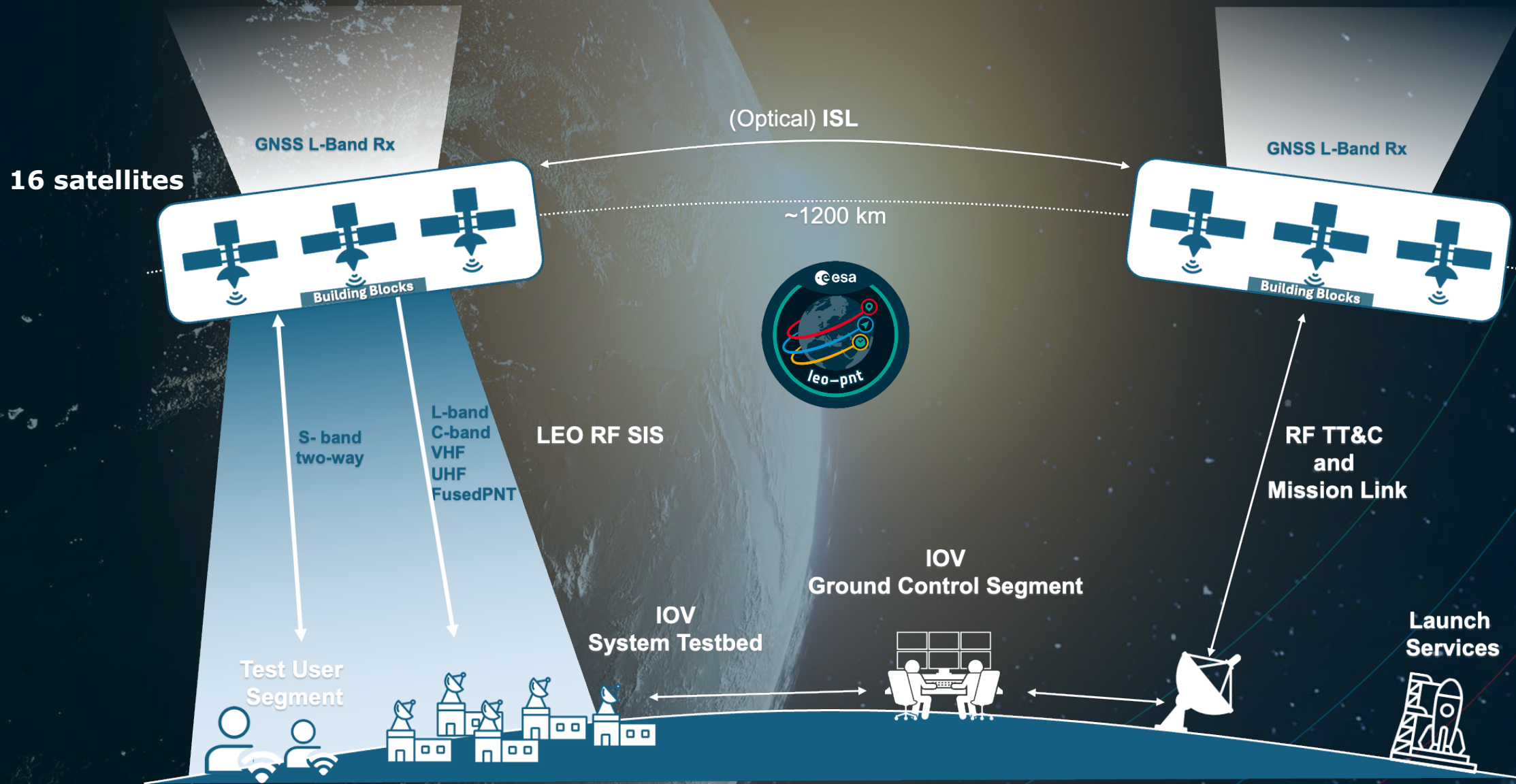
Validate the selected candidate missions over Europe through an In-Orbit Validation phase. This includes validating signals and associated performances and bring frequencies into use.



Develop open standards in collaboration with international stakeholders, enabling interoperability, also supporting commercial initiatives.

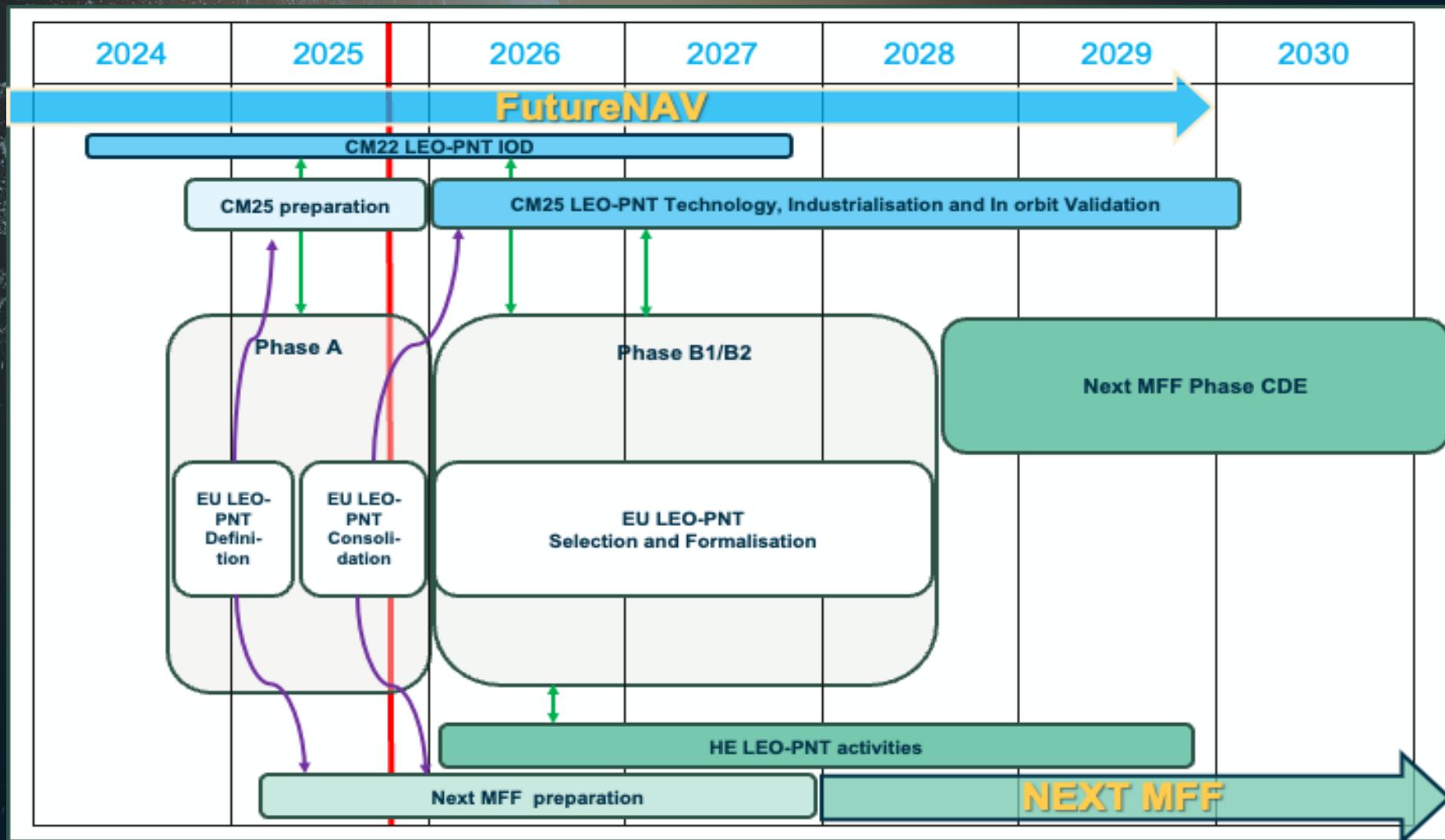


# LEO-PNT In-Orbit Validation Architecture



# ESA-EU Reinforced Coordination on LEO PNT -

□ **Collaboration ESA/EC** towards a joint vision and LEO PNT integrated roadmap





# Conclusions and Next Steps

- A **LEO layer for Positioning, Navigation and Timing** is a promising opportunity to improve GNSS resilience and robustness, improve GNSS performance and provide new services.
- Through the **FutureNAV program**, ESA pursue to foster the **European LEO-PNT ecosystem**
- The **ESA LEO-PNT In-Orbit Demonstration with 2 parallel contracts is underway** at fast pace, to pave the way for a European GNSS LEO layer.
  - **10 In-Orbit Demonstrator satellites** will be launched within the next 3 years
- Possible opportunities for **future operational system are under investigation** from both perspectives Institutional (in coordination with EU) and Commercial.
  - ESA-EU integrated roadmap towards a potential EU LEO-PNT implementation in the next MFF.
- A **LEO-PNT Industrialisation and In-Orbit Validation Phase** is proposed in the next phase.
  - **Important opportunities for Dutch industry and academia!**



THANK YOU



FutureNAV  
Industry Day

SHAPING THE FUTURE OF NAVIGATION

18 February 2025  
ESTEC, Netherlands

**RFI on LEO-PNT Industrialisation in February!**

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→ THE EUROPEAN SPACE AGENCY