



ESA AO/1-9427/18/NL/MP – NAVISP-EL-3-018
Space for Urban Air Mobility space-based services

itAlian Urban aiR mObility technologies
& distrRibuted test-fAcility

NAVISP Industry Days 16-17 June 2022

Ennio Borgna – ENAC
Marco Romani - Telespazio



Why AURORA project

UAM background & market perspective

United Nations latest analysis estimates that **in 2050, over 60% of the world population will live in urban areas**. As demand for transportation continues to increase, alternatives to ground-based transportation have emerged to enable urban travel and commuting. Skywards urban transportation is a new transport solution that requires the convergence of technologies coming from aerospace, infrastructure, communication and intelligent mobility eco-systems.

Moreover, according to Agenda 2030 for **Sustainable Development Goals** (SDG), this study is compliant to SDG9 (Build resilient infrastructure, promote sustainable industrialization and foster innovation) and SDG11 (Sustainable cities and communities).

Latest market forecast by NASA & Booz Allen reports UAM (Urban Air Mobility) is currently in its infancy, with the first commercialization expected by 2023. However, its projected growth is significant: it is estimated an **annual growth rate of 16.2% by 2030**, with an estimated global value from 3.1bn by 2023 to **7.9bn US Dollar by 2030**.



Many city administrators have put Smart City policies at the centre of their plans, with UAM a core component. While the timescale for full deployment is uncertain and many obstacles still lie ahead, UAM and VTOLs undoubtedly have a part to play in the future development of urban environments.

In order for this game-changing technology to truly emerge, **it is important that all industry stakeholders, lobby governments and regulators provide a legal and regulatory framework that will allow the technology to develop in a safe and open AAM (advanced Air Mobility) environment.**



Why **AURORA** project

UAM/AAM Italian strategy according to European strategy

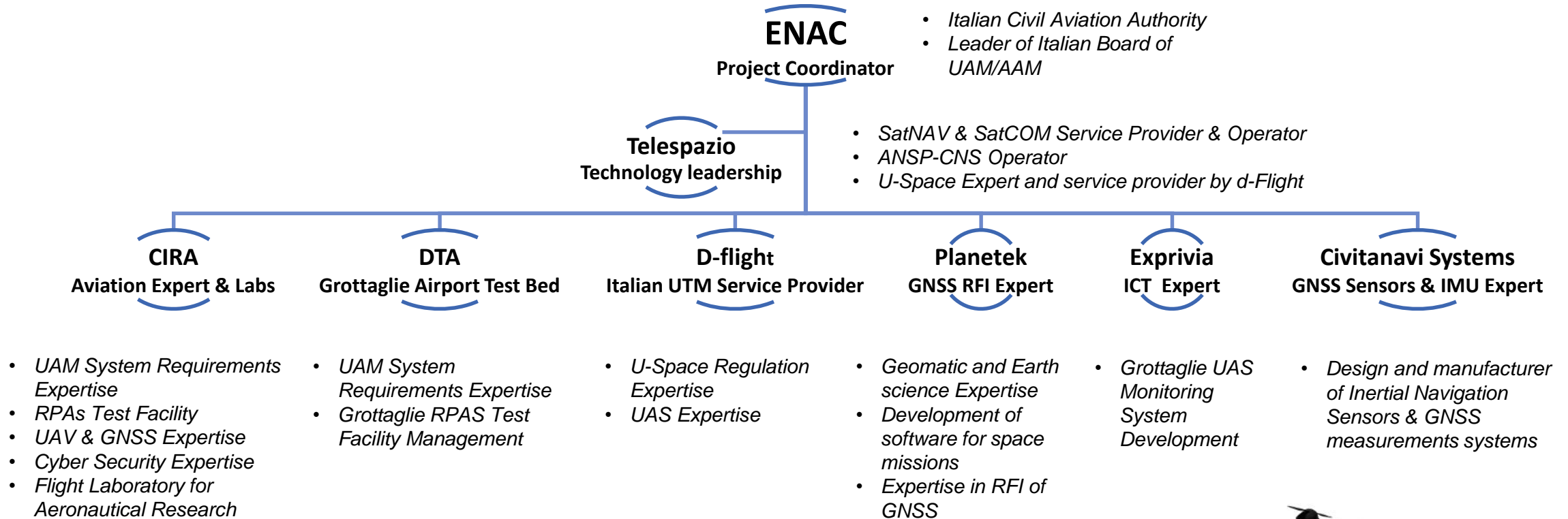
AURORA intend create a **Public** and **Private technological ecosystem** to respond of following UAM initiatives:

- In the “**Digital European Sky - Blueprint**” , SESAR Joint Undertaking addresses the concept of Urban Air Mobility related to U-space and its services. SESAR JU states that one of the most challenging use cases from U-space will be to enable urban air mobility, which is expected to advance autonomous technologies in a number of areas.
- At national level, in **2019, ENAC signed an agreement of understanding with the Minister of Innovation (MID)** for the launch of a national Urban Air Mobility (UAM) project: so-called "Innovation e-Mobility" with the purpose of foster a sustainable mobility model and CONOPS with a low environment impact.
- **AAM National Strategic Plan (2021-2030) for the development of Advanced Air Mobility in Italy** , issued by ENAC is the results of National working group of public and private Stakeholders, aimed to create an Italian ecosystem for Advanced Air Mobility (AAM) common strategy.
- Reinforce and make **synergy between the major industrial players** operating in the Unmanned Aviation and Navigation (GNSS-PNT) sectors.



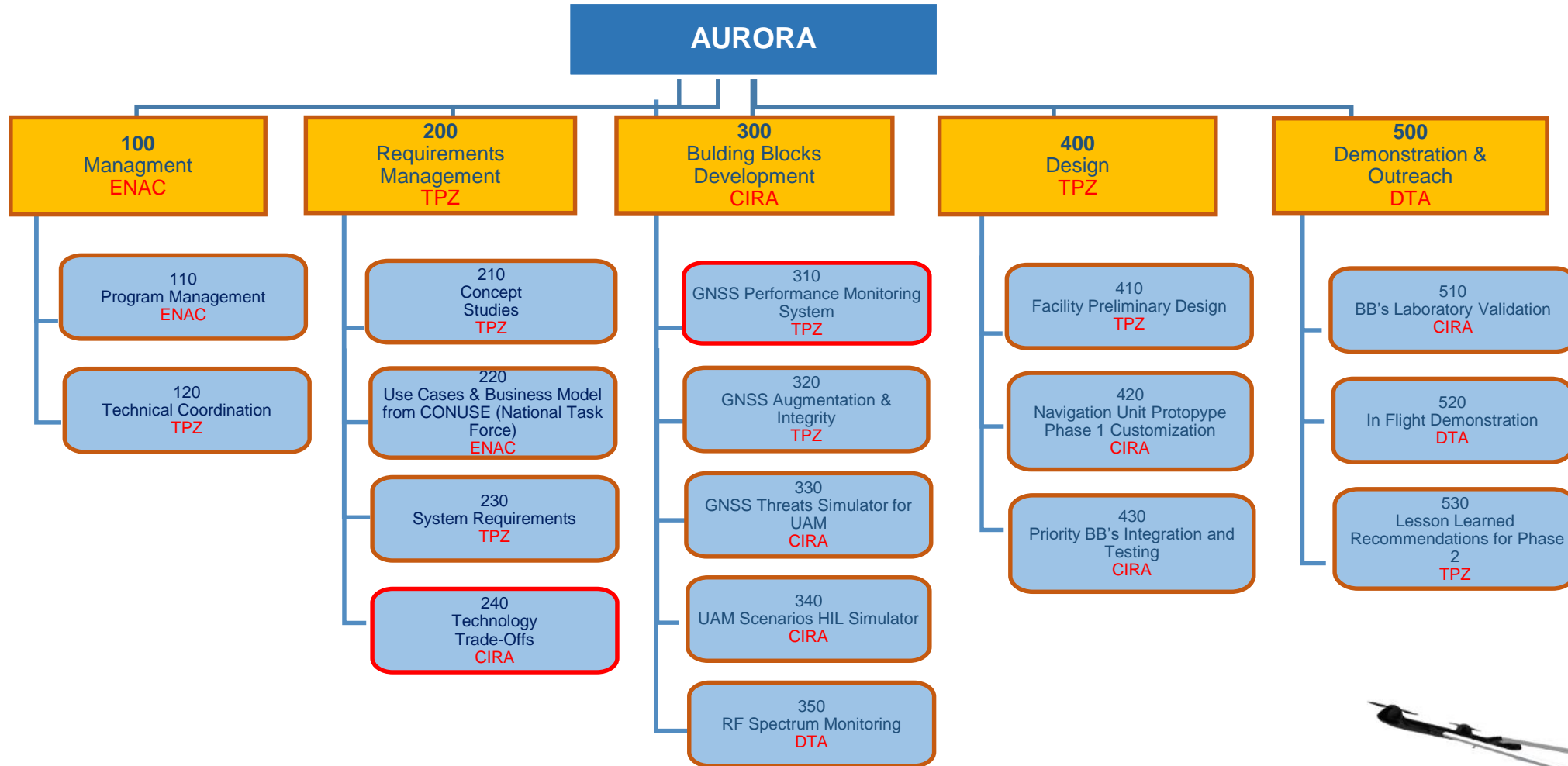
Team

Public body leading of an industrial group of skilled companies



Organization and Governance

Work Breakdown Structure



Objectives and Goals

1. **Define the PNT Requirements (obj)** and Design a GNSS Based Architecture for Urban & Advanced Air Mobility (UAM/AAM).
2. **Put in place a GNSS based PNT distributed testing infrastructure (goal)** addressed to UAM/AAM needs.
 - laboratories of DTA, CIRA and TPZ, with definition of the standard interoperability protocols and procedures that would allow future addition of other facilities and/or other experimental assets outside the current consortium. AURORA will be exploited not only by the members of the consortium, but even by third parties such as manufacturers, technology providers, application developers and service providers
3. **Investigate new PNT technologies for UAM applications (obj)**, performing laboratory and in-flight demonstrations of their effectiveness.
 - GNSS Performance Monitoring System; GNSS Augmentation and Integrity System; RF Spectrum Monitoring System; GNSS Threat Simulator for UAM and Hybrid GNSS/IMU Navigation Unit

According to ESA and ASI recommendations, AURORA is a 2 phases project initiative:

Phase 1 (from 01/2022 to 08/2023) aims to **design the UAM National infrastructure and its preliminary validation**

- through development of **new GNSS Priority Building Blocks (PBBs)**, considered fundamental for monitoring the health and performance of GNSS signals in the UAM/AAM context - Multi-Constellation/Multi-Frequency (MCMF) GNSS receivers and Hybrid GNSS/Inertial Measurement system.

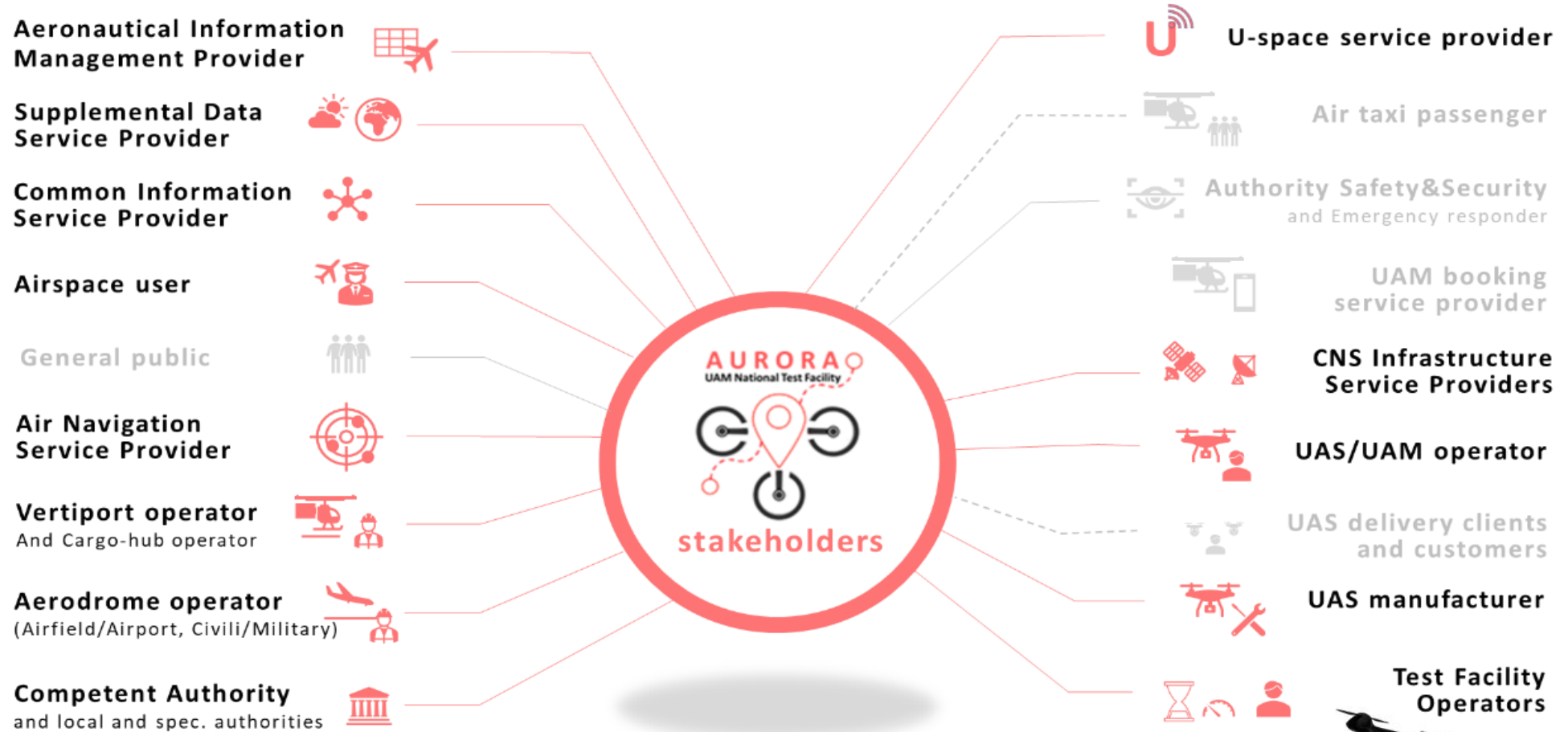
Phase 2 will be focused on **realization of the UAM National infrastructure and demonstration of its capabilities**

- by fully testing the GNSS technology building blocks that would support the implementation of national strategy plan for Advanced Air Mobility.



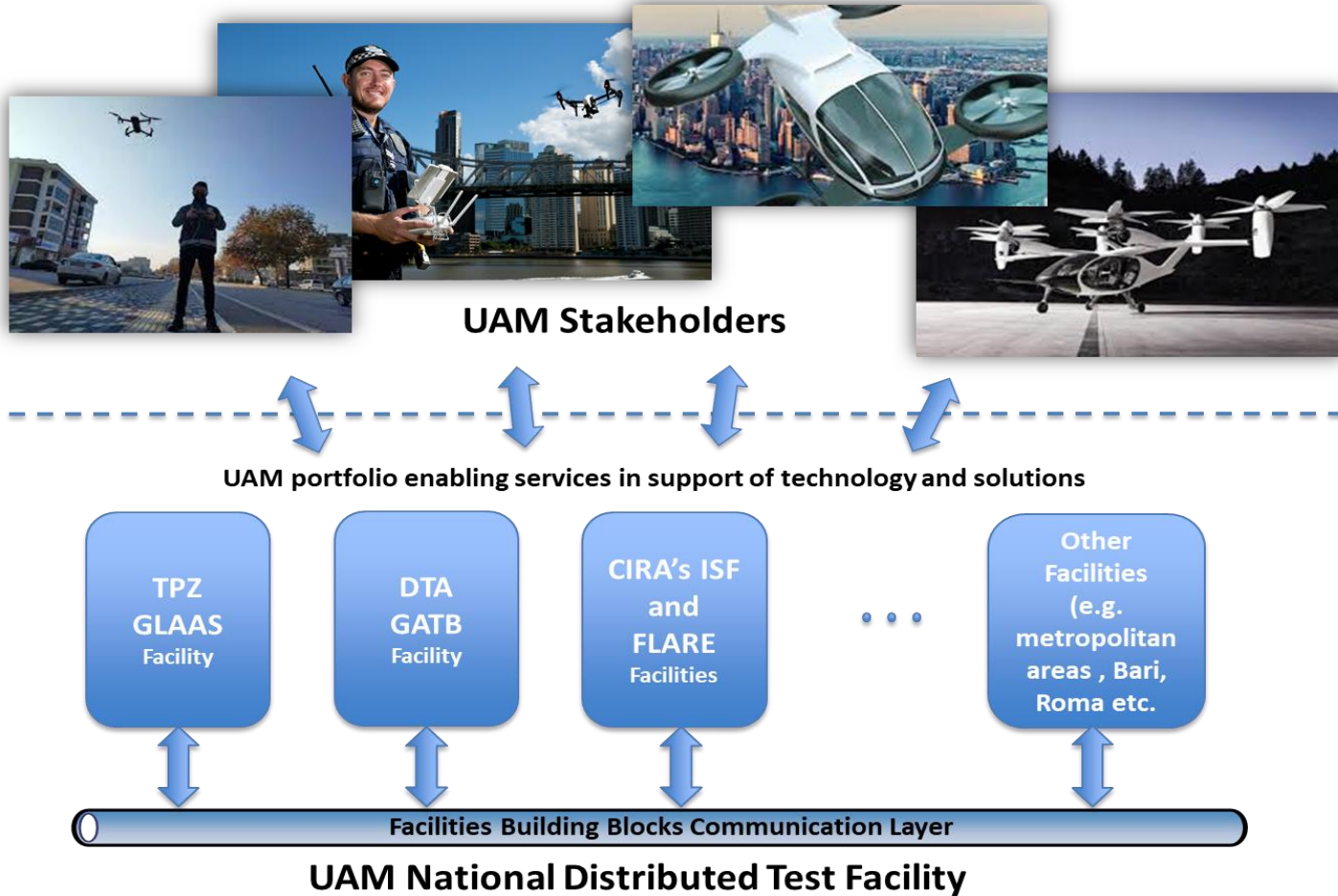
AURORA Stakeholders

Public and Private players



AURORA PNT Distributed Test Facility

Overview of land distribution



Distributed test facility baseline on 3 sites:

- **GLASS** - GNSS-PNT test labs at Rome from Telespazio.
- **GATB** - Airport of Grottaglie – Taranto Test Bed of DTA.
- **CIRA's labs** of Aeronautical technology at Capua (Naples) and experimental vehicle **FLARE** (P92-Echo S of Tecnam – optionally pilot).

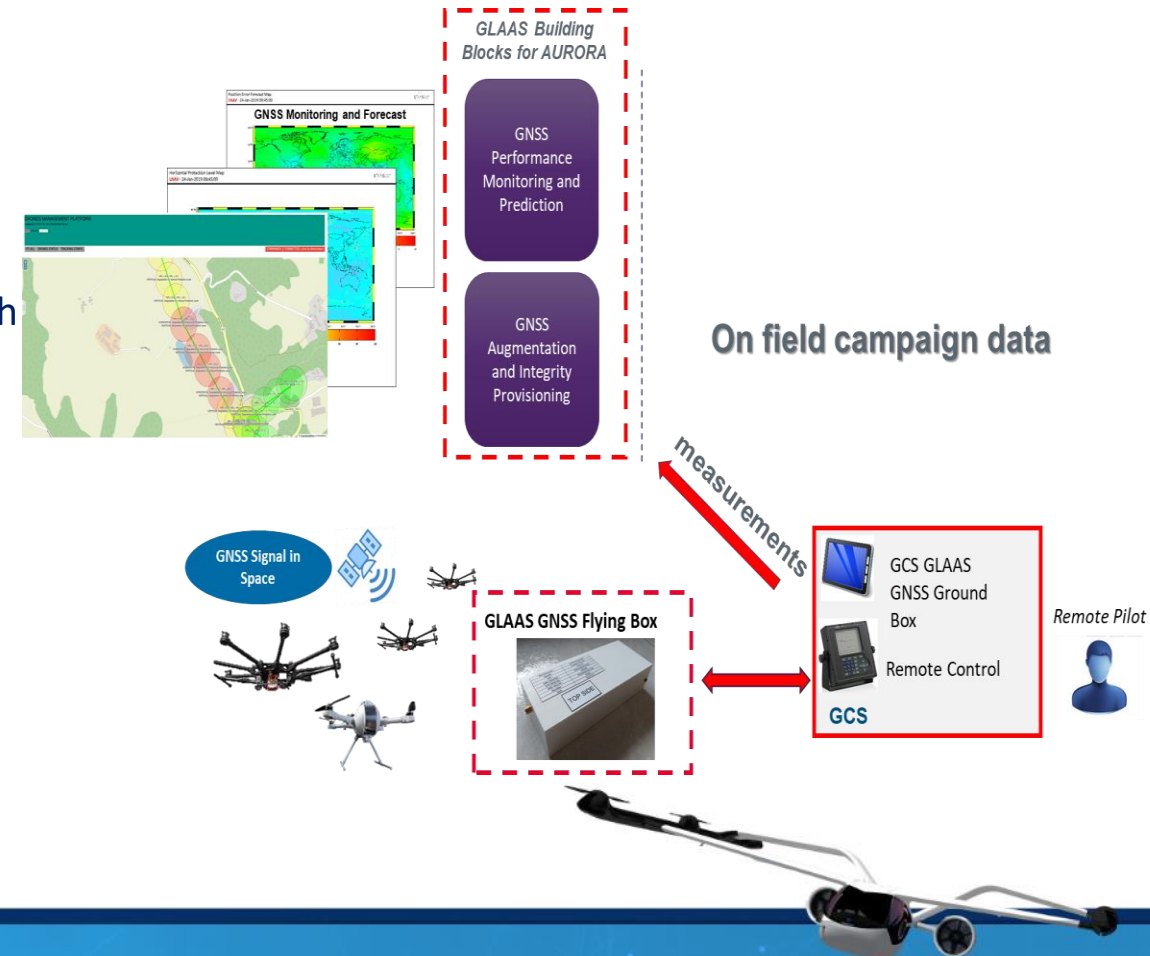


GLASS - Gns Laboratory aS a Service

Independent GNSS Reference Laboratory

GNSS-PNT Reference Laboratory support the following main HW & SW capabilities

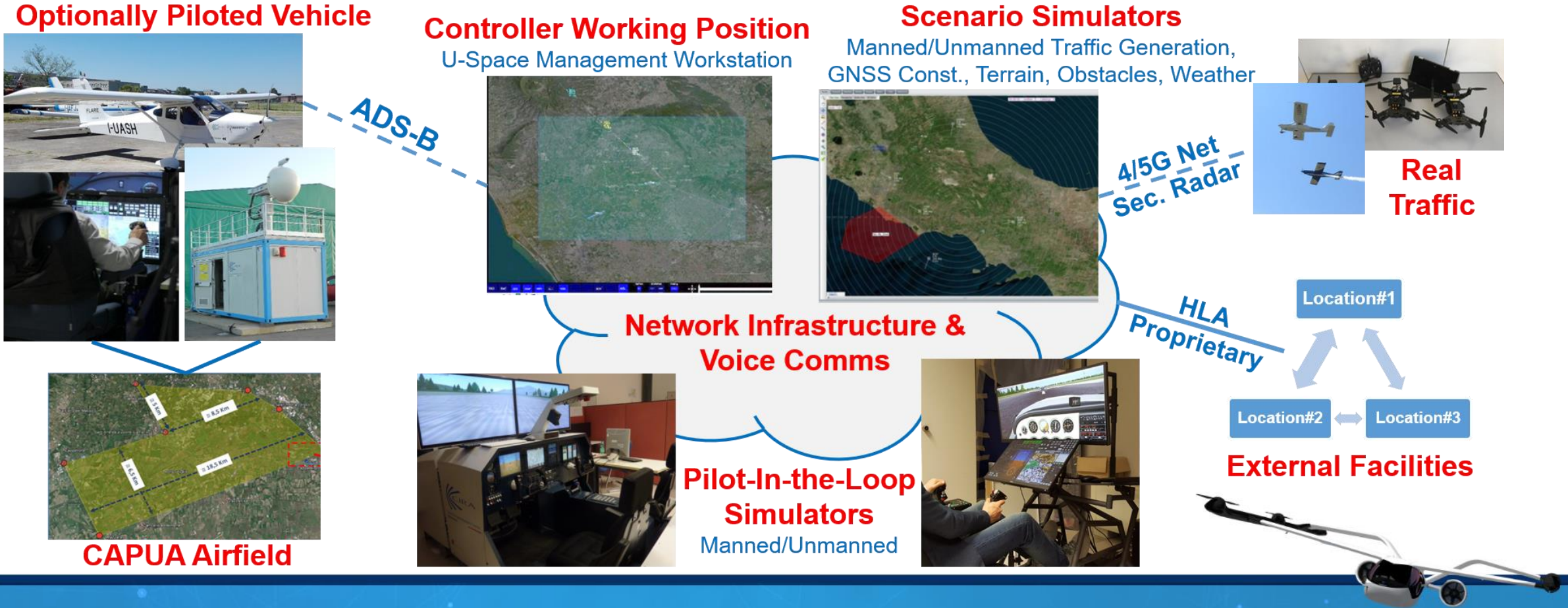
- RFCS Spirent GSS 9000 capable to simulate till 12 Galileo (E1, E5, E6) and 12 GPS (L1, L5) satellites in view;
- AWG Agilent N5172B (frequency range from 100 KHz to 3 GHz);
- Record and Play-back system (RPS) Spirent 6425 (BW 50 MHz, 2 bit-depth I&Q);
- Real Time Spectrum Analyzer Tektronix 5100A;
- Septentrio receivers (PolarX 4 TR PRO, PolarX S PRO and PolarX 3eG);
- Active GNSS Antennas (supported frequency bands E1/E5/E6);
- Spirent SimGEN SW for the generation and monitoring of the simulation environment;
- Spirent SimSENSOR SW for simulating the output of INS systems;
- GNSS Assistance Data Dispatcher SW;
- NovAtel GrafNav Post-Processing SW (RKT and PPP);
- In house developed post-processing tool for GNSS navigation data specific analysis (eg. KPI and metrics generation)



CIRA's Labs of simulation and Flight test facility (FLARE)

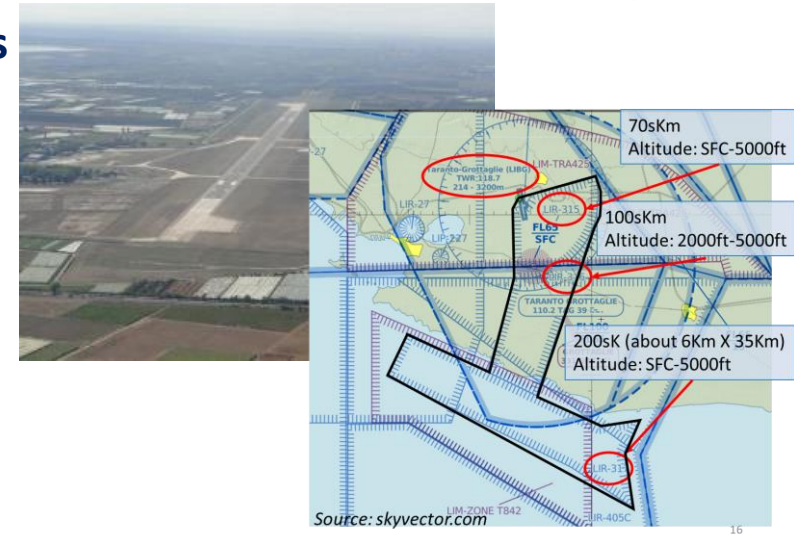
- CIRA's facility optimally mixes simulators with real vehicles and equipment to perform experimental validation of new technologies up to TRL6 in complex, multi-agent scenarios
- Currently used in several national and international projects (PRORA, SESAR, EDA, HE, CS2, etc.)

FLARE



GATB - Grottaglie (TA) Airport Test Bed

- Technological facility (UAS in ATM simulation), airport and segregable airspaces
- Services: flight tests design, set-up, authorization, realization
- UAS flight tests (done and planned): EDA, EUSPA, ESA, SESAR, MUR, MISE, ASI, Regione Puglia
- Drone Living Lab (DTA, ENAC and Municipality of Bari) to experiment and demonstrate innovative UAM (and EO) services for the city of Bari
- Drone Beyond – 2021 session: large demonstration in conjunction with Mediterranean Aerospace Matching event



GNSS Priority Building Blocks

Development, Verification and Validation



Development chain

- GNSS Performance Monitoring System
- GNSS Augmentation and Integrity System
- GNSS Threat Simulator for UAM
- Hybrid GNSS/IMU Navigation Unit

GLASS

- First flight Validation and demonstration using FLARE aircraft

CIRA

- RF Spectrum Monitoring System
- GNSS Augmentation and Integrity System

GATB

Verification & Validation

Integration within the Hardware In the Loop Simulation Facility

CIRA

Test of new PNT technologies for UAM applications

GATB

Upgrade of the system to get a better coverage of GNSS Spectrum

GLASS

Exploiting of GNSS flying box functionalities

1) Compliance to the National UAM/AAM context and CONOPS.

2) Improvement of GNSS features in order to include UAM/AAM specific issues and Use Cases.



Project activities

Successfully completed

Starting from the analysis of Use Case and Business Model developed by the National Task Force on Advanced Air Mobility (the CONUSE), WP210 and 220 will issue the following documents first:

D1 - State of the art of navigation technologies for UAM/AAM

Survey of the open literature and current projects identifying the GNSS/PNT and sensor technologies providing added-values for UAM/AAM

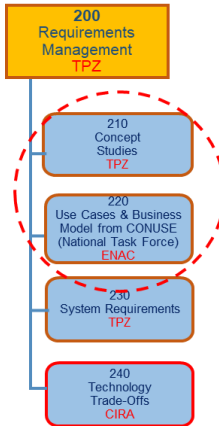
D2 - Concept Studies Technical Dossier

Analysis of critical technologies and current gaps that shall be filled in the development of Navigation infrastructure addressed to UAM/AAM

D3 - Use cases & operational scenarios technical note

Description of operational scenarios compliant with national UAM/AAM regulations and definition of specific use cases addressing the design and implementation of the UAM Navigation Distributed Facility

Del ID	Doc Title	Type	WP	Delivery Date
D1	State of the art of GNSS technologies to support air navigation of unmanned aircraft and identification of Critical Areas	Report	210	T0+3m
D2	Concept Studies Technical Dossier	Report	210	T0+3m
D3	Use cases & operational scenarios technical note	Report	220	T0+3m

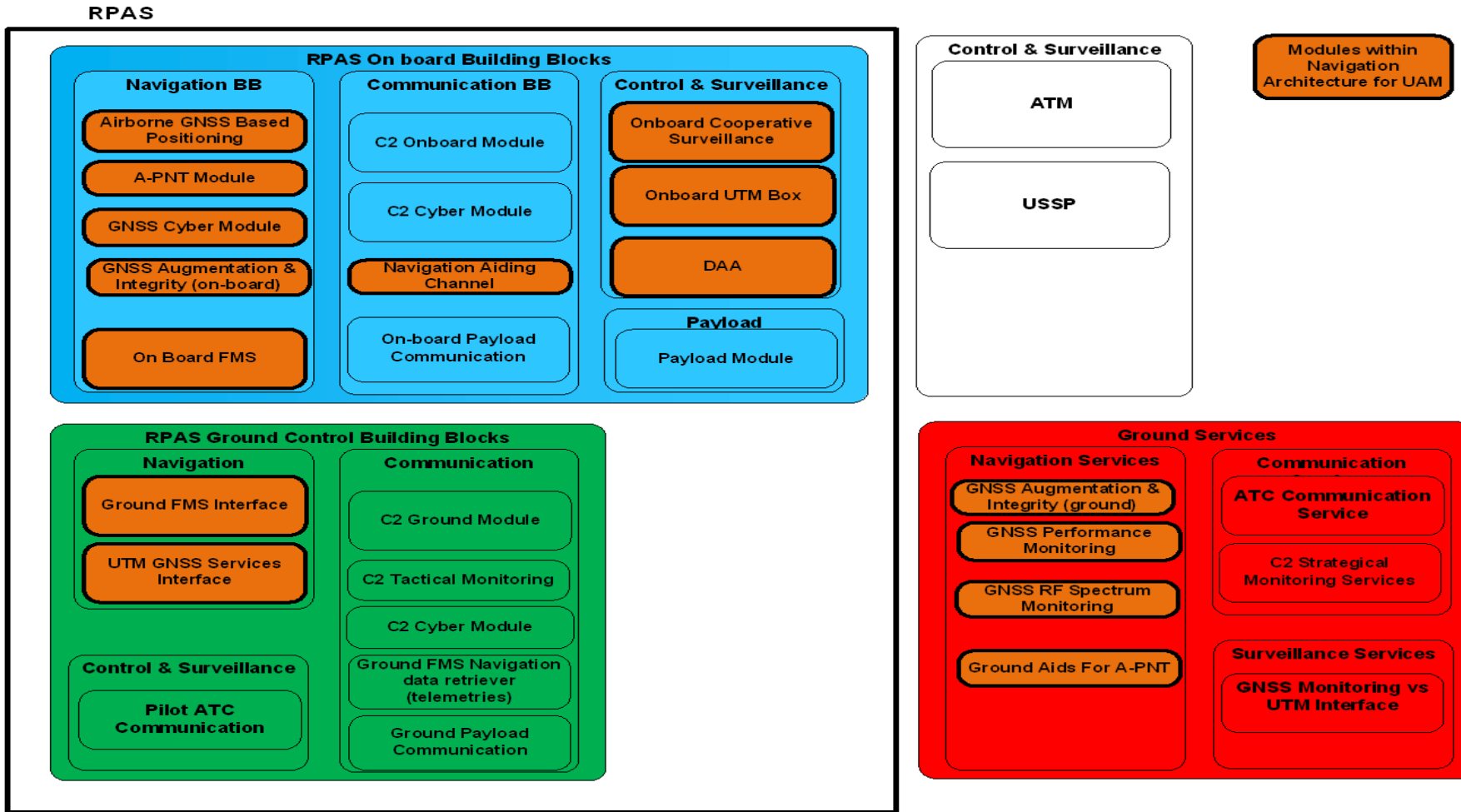


--- D1, D2 and D3 represents the pillars for definition of UAM Distributed Facility System Requirements ---



Deliverable #2

Infrastructure concept studies - Technical dossier



Deliverable originates from the critical analysis of current GNSS-PNT technologies, solutions and applications in civil aviation domain

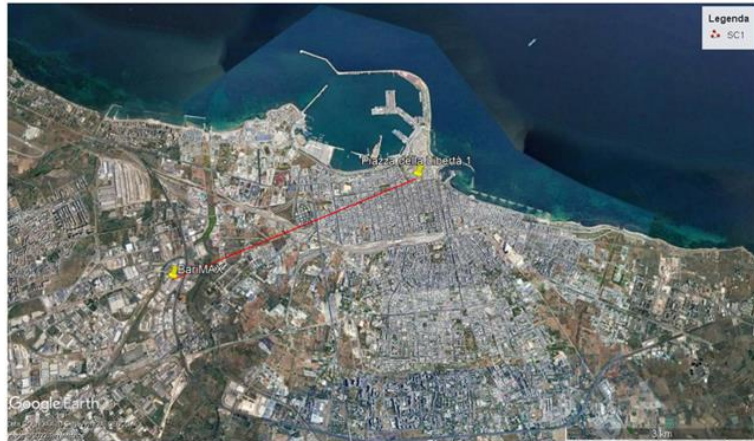
Deliverable #3

Use cases & operational scenarios - Technical note

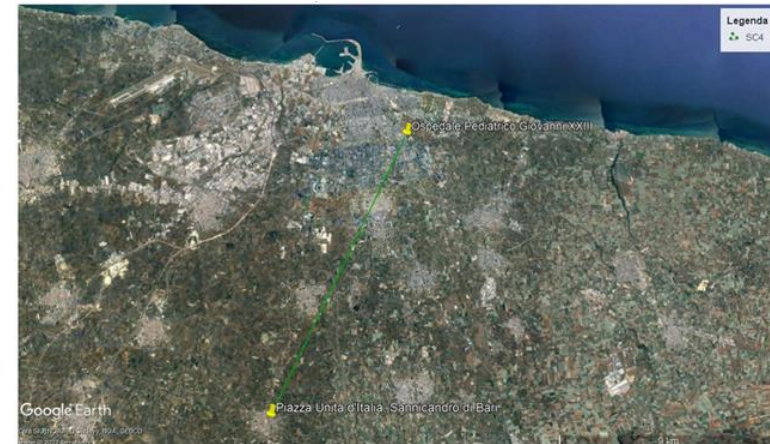


Use case ID	Main Actor	Summary
UC-RE-01	UAS/UAM Operator	Navigate in high-risk environment (e.g. trasporto di persone/cargo in ambiente urbano ed extraurbano (air-taxi/air-cargo/medical and good delivery));
UC-RE-02	UAS/UAM Operator	Navigate close to an infrastructure (e.g. inspection and mapping)
UC-RE-03	UAS/UAM Operator	Navigate in low-risk environment (e.g. precision agriculture)
UC-RE-04	-Nav Infrastructure SP - U-space airspace supervisor	Monitor of Navigation Infrastructure

Direct last-mile delivery



Point-to-everywhere



This deliverable originates from the analysis of: Use Case, Operational Scenarios and Business Model, defined by the National Task Force on Advanced Air Mobility (the CONUSE) and reported in "Piano Strategico Nazionale AAM" issued by ENAC.



Project activities in-progress for SRR

Starting from D1 (State of the art), D2 (Concept Studies) and D3 (Use cases) WP230 and 240 will issue the following documents:

D4 - System Requirements

Definition of system requirements related (SR) to the UAM National Facility that are derived from user requirements (UR) and selected use cases (UCs)

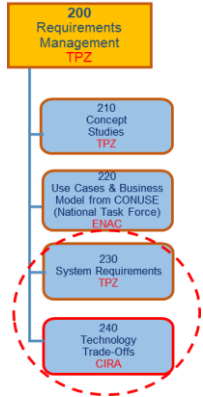
D5 - Trade off PNT technologies and Development Roadmap for UAM/AAM

Report the results of trade-offs related to different navigation technologies that can be used for UAM (GNSS and related augmentation systems, Inertial Measurements, 5G, Visual Aids, radars, etc.)

D16 - System Verification and Validation Plan

Definition of plan addressed to the integration, testing and demonstration of UAM Distributed Facility functionalities foreseen for the Phase 1 of the Project

Del ID	Doc Title	Type	WP	Delivery Date
D4	System requirements document	Report	230	SRR (T0+6m)
D5	Trade off PNT technologies and Development Roadmap for UAM/AAM	Report	240	SRR (T0+6m)
D16	System Verification and Validation Plan	Report	230	SRR (T0+6m)



--- D4, D5 and D16 are originated from the design and development activities of UAM Distributed Facility ---





MANY THANKS
FOR YOUR ATTENTION!