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EUROPEAN SPACE AGENCY

PROGRAMME BOARD ON SATELLITE NAVIGATION

NAVISP Element 1 Work Plan for 2022

Subject

This document presents the NAVISP Element 1 Work Plan 2022 activities.

Required action

The participating States in NAVISP Element 1 are invited to approve, by simple majority, the Element 1 Work Plan for 2022.

Voting rights and required majority

Simple majority of the Participating States in the Element 1 of the NAVISP Programme (AT, BE, CH, CZ, DE, DK, FI, FR, GR, HU, IT, NL, NO, RO, SE, UK) representing at least half of the contributions to this Element.

Legal Basis

Act in Council on the Introduction of Weighted Vote in the Agency's Optional Programmes (ESA/C/CCXXIX/Act 1 (Final) attached to ESA/C(2012)102).
Article 3 (d) of the Implementing Rules of the NAVISP Programme.

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1. INTRODUCTION

Activities under Element 1 of the Navigation Innovation and Support Programme (NAVISP) are defined and implemented according to an annual work plan to be prepared and proposed by the Agency, and to be approved by participating States in Element 1. The annual work plan is prepared on the basis of appropriate consultation with the participating States and ex-ante coordination with the European Commission (EC) and the European Union Agency for the Space Programme (EUSPA).

This document presents the Element 1 Work Plan for 2022.

2. PREPARATION OF NAVISP ELEMENT 1 WORKPLAN FOR 2022

Notwithstanding difficulties for external interactions due to the Covid-19 crisis, the Executive has managed to apply the well proven ‘funnel scheme’ to collect the most promising proposals for the Element 1 Work Plan for 2022.

First the Executive has collected inputs through an ESA-wide consultation, and later from external stakeholders, mainly from NAVAC, and also through solicitation via the NAVISP website. Then the Executive has refined the inputs with the ultimate purpose to populate the work plan according to well-established guidelines.

Proposals have taken into account preliminary comments received through the intermediate round of formal consultations with the EC, EUSPA and participating States on the ‘Draft NAVISP Element 1 Work Plan 2022’ (ESA/PB-NAV(2021)21) presented at the 119th PB-NAV meeting.

3. STATUS OF COORDINATION

The Element 1 Work Plan for 2022 has therefore been shared with the EC and EUSPA through two rounds of formal consultation on both its draft and final versions. This process has been carried out strictly in line with “Coordination between the EC-GSA and ESA on NAVISP Programme Activities” (ESA/PB-NAV(2016)34). Comments received by the EC and EUSPA have been taken into account, and text describing the proposed activities has been updated for the sake of clarity.

4. RATIONALE AND DESCRIPTION OF PROPOSED ACTIVITIES

The NAVISP Element 1 workplan support the foundations for future innovative PNT developments, the aim being to attract industry interest in the wider PNT domain and offer the possibility of developing new solutions by accessing and combining relevant space and non-space know-how, techniques and technologies.

Element 1 is basically the exploratory component of NAVISP, and the innovative and disruptive nature of the idea is what matters. New solutions (systems, equipment, products, algorithms, techniques, technologies) are generated and their feasibility is assessed, tested and demonstrated, with recommendations for follow-on activities.

Currently, Element 1 nature, size and participation does not allow to cover organically most of the recommended follow-on developments (e.g. to increase the TRL of the demonstrated innovative solution), unless this is brought forward by industry in Element 2 or national institutions in Element 3.

Inputs requested had to meet the NAVISP Element 1 eligibility criteria:

- Addressing innovative PNT concepts, techniques and technologies
- Avoiding overlap with other on-going or planned activities and not addressing EGNSS evolutions

Upon NAVAC recommendation, proposals within the following four areas were encouraged:

- Autonomous Transport and Green Mobility;
- Seamless PNT applications for Industry 4.0, e.g. for indoor infrastructure logistics;
- Alternate PNT timing, alternative or complementary to GNSS;
- PNT Robustness and resilience.

The resulting Work Plan 2022 includes:

- one activity addressing a promising innovative technology for seamless PNT;
- two activities addressing the advancement of technologies for robust and/or alternative PNT;
- three activities addressing the advancement of PNT technologies known but not yet fully exploited or developed, e.g. in the domain of autonomous vehicles.

In addition the Work Plan also includes one activity in support of the preparation for Lunar PNT activities in coherence with previous Work Plans.

Finally, following the presentation of the draft Workplan at the 119th PB-NAV, an additional activity for an Advanced MEOSAR Test Beacon Setup has been identified, and added to the Work Plan.

4.1. Promising innovative technology for seamless PNT

4.1.1. NAVISP-EL1-063: RIS-aided wireless localization and mapping

Propagation at radio frequency suffers from obstructions due to objects blocking Line of Sight (LOS) path between the transmitter and the receiver. To increase the probability of LOS from a sufficient number of transmitting points, PNT systems imply sufficient densification and time synchronization. In spite of all these, many blind spots continue to degrade the positioning performance.

A solution is to deploy dedicated pseudolites systems such as e.g., Locata, which have a proven record of working with good performance. The dependency on the LOS path can also be reduced through disruptive initiatives such as multipath-aided localization by exploiting man-made structures with programmable reflection and refraction properties and embedded in the built environment called Reconfigurable Intelligent Surfaces (RIS). RIS is a novel technology to construct radio environments by deploying a programmable surface able to reconfigure the wireless propagation environment by carefully tuning the phase shifts of a large number of low-cost passive reflecting elements. In more simple words, RIS can control the direction of radio wave reflection. RIS added values are as follows: direction can be dynamically reconfigured via SW without changing the pointing of the antenna; they are passive elements that can be used primarily for improving communication services but also exploited for positioning, therefore they are expected to be more cost efficient; no extra costs are imposed on the user equipment as there is no need for additional dedicated HW as is the case with pseudolites; and no additional regulatory aspects and minimal energy consumption due its passive nature. Lastly, based on the fundamental operating modes, a RIS can act as transmitter, receiver, or as a reflector, where the direction of the reflected wave is no longer specular according to natural reflection laws but steerable.

The objective of the proposed activity is to demonstrate metamaterials can be used to control the EM environment to achieve accurate multipath-aided positioning with low resources. Through this activity several important outstanding challenges for RIS-based localization are expected to be overcome: signalling and system architecture, RIS control (i.e. steering the incident beams in a direction of interest), waveform design, and localization algorithms.

RIS is a topic that is gaining more and more notoriety in the last years, both in the academic environment (Heriot University, University of Glasgow – UK, University of Trento – IT, AIT Austrian Institute of Technology – AT, Linkoping University – SE, etc.) and industry (Nokia, Montimage GmbH, etc.). Nevertheless, RIS-aided localization has never been studied in a configuration with a uniform planar array nor demonstrated even in laboratory environment. This activity could also contribute to the prototyping of a novel 3D mapping and localization system.

Ultimately, this activity, based on field trials, will attempt to validate the hypothesis that positioning with a single transmitter can be performed by exploiting RIS surfaces and synthetic NLOS signals.

The tasks to be performed will include:

- Investigate use cases (localization, sensing, etc.) and deployment scenarios (indoor, urban)
- Study channel models, RIS components (active vs passive vs reflective pattern), beam management, control of RIS, waveform design, etc.
- Develop and test protocol for controlling the RIS, localization algorithm(s)
- Test the proof of concept in lab environment based on measurement campaign

As a result, the TRL at the end of the activity should be 4.

The main outputs of the activity will consist of:

- Localization algorithms for RIS-aided positioning
- End-to-end Breadboard for data sets for RIS-aided positioning
- Demonstrate RIS-aided positioning based on field campaigns carried out in lab environments

Funding required: 500k€	*Duration:* 18 months	*ITT issue:* Q4 2022

4.2. Advancement of technologies for robust and/or alternative PNT

4.2.1. NAVISP-EL1-064: Block-box for an optimised GNSS spectrum monitoring network using AI

There is an abundance of GNSS receivers deployed around the world providing measurements and PNT information, which are currently combined into networks for a variety of GNSS processing and monitoring applications. However, these receivers remain vulnerable and cannot be used to isolate all sources of error on all GNSS signals and constellations due to the processed nature of the receiver output, which is receiver-specific and sometimes also due to the encrypted nature of the transmitted GNSS signals.

To overcome these difficulties, it is proposed to develop the Block-box, an external RF2RF device targeting the enhancement of any COTS GNSS receiver.
It can be tuned to a variety of applications at user, downstream services or system level supporting monitoring functions and real-time signal cleaning.

It is based on AI helping to detect and categorise signal and system anomalies and interference. The starting TRL is low and expected to be raised during the activity taking past and current TRP activities (TERMINATE and AIMGNSS) as input. These detection capabilities will aim to be remotely upgradeable with newly trained models in order to, for example, keep up with constantly expanding and increasingly sophisticated RFI/jammer profiles.

Observations are based on measurements directly taken in the Block-box from its GNSS spectrum Intermediate Frequency (IF) samples and on measurements coming from the associated COTS GNSS receiver and enhanced by the Block-box. Rejection of interfering signals is performed on the same RF signal injected in the COTS GNSS receiver.

In order to support monitoring functions, Block-box will buffer recent IF samples to capture the period around an event detection. These samples can be stored and used later, for example, to test and tune new receiver algorithms.

Extra parameters for integrity are also targeted in the block-box by enhancing the raw measurements of the GNSS receiver and the detection of satellite signal anomalies, e.g evil waveforms, exploiting the potential to network several devices together.

The objectives of the proposed activity are to investigate, prototype and validate an RF2RF GNSS receiver enhancement device, the Block-box. This device uses a GNSS spectrum sampler in order to monitor and clean the incoming signal, making use of AI/ML techniques.

The tasks to be performed include:

- Reviewing state-of-the-art monitoring and signal cleaning techniques using AI;
- Defining of relevant use-cases, environments and concepts of operation;
- Designing, development and breadboarding of a not full-scale breadboard model of the block-box device and SW algorithms;
- Verifying and demonstrating the basic functional performance. The verification includes tests in laboratory environment and performance verification through testing in the relevant environment, subject to scaling effects.

The main output of the activity will consist of:

- Block-box breadboard verified in relevant environment (TRL 4-5)
- Documentation including:
    - o Preliminary definition of performance requirements and of the relevant environment (Preliminary technical requirements specification)
    - o Analysis report for technology associated with critical functions
    - o Preliminary design of the element, supported by appropriate models for the verification of the critical functions (Preliminary design definition file)

- o Preliminary design justification file including: identification of computational design methods and tools; analysis of scaling effects; breadboard definition for the verification of the critical function of an element;
- o Test plan and reports

Funding required: 450k€	*Duration:* 18 months	*ITT issue:* Q2 2022

4.2.2. NAVISP-EL1-065: eLoran antenna for handheld devices

Enhanced-LORAN (eLoRAN) is the latest of the low-frequency LOng-Range Navigation (LORAN) systems, and provides a PNT service for use by all modes of transport (land, maritime and aeronautic). Amongst other characteristics, e-LORAN can enhance geo-security through its jam- and spoof-resistant signal characteristics of high transmit power and low carrier frequency. Furthermore, the signal can be used for precision timekeeping. It is a good candidate as an alternative and/or backup to the GNSS navigation systems. It is operating at the frequency band 90 - 110 kHz. At these low frequencies, classical antennas (generally magnetic loop and loaded monopole antennas) are of relatively large size, which is not adapted to professional handheld consumer electronic devices. For the professional handheld electronic device market, the antenna has to be miniaturized, by keeping it efficient enough to receive and process e-LORAN signals both outdoors and indoors.

In order to support the development and the diffusion of the very low frequency application in the PNT landscape, the development of a new miniaturized and robust e-LORAN antenna (with dedicated Low Noise Amplifier [LNA]) is considered very important and shall be developed in this activity.

The new antenna shall be mounted on handheld devices, for the localization of users in situations, in which the current GNSS is unavailable or degraded.

The antenna requirements will be derived from NAVISP Element 1 study "Combining ELF signals with GNSS for improved PNT" (NAVISP-EL1-046).

The objectives of the proposed activity is the development of the breadboard of a miniaturized and robust e-LORAN user antenna, with integrated LNA, suitable for the professional handheld devices market.

The tasks to be performed will include:

- Study on state-of-the-art e-Loran receivers, as well as requirement review
- Design and analysis of the antennas to fit on professional handheld user terminal
- Manufacturing of the antenna demonstrator and associated testing

The main output of the activity will consist of the documentation related to each task and the manufactured e-LORAN handheld antenna demonstrator (with dedicated LNA) developed up to breadboard verification in laboratory (target TRL4).

Funding required: 250k€	*Duration:* 18 months	*ITT issue:* Q3 2022

4.3. Advancement of PNT technologies known but not yet fully exploited or developed

4.3.1. NAVISP-EL1-066: Deeply Coupled GNSS Vector tracking loop robust solution for autonomous vehicles

In conventional GNSS receivers (Scalar Tracking Loop – STL), tracking is performed in several independent tracking loops that provide measurements (pseudoranges, pseudorange rates, carrier doppler) to a navigation algorithm (e.g. kalman filter) in charge of the PVT solution.

In Vector Tracking Loops (VTL), the two tasks of signal tracking and PVT estimations are combined. This allows the exploitation of the inherent coupling between the dynamics in each channel and the dynamics of the receiver. In the vector architecture the navigation filter estimator closes the signal tracking loops by generating corrections for the code and carrier numerically controlled oscillators (NCO).

Past studies of VTL architecture in urban environment have confirmed the benefits of VTL compared to conventional receivers (Scalar Tracking Loops) to maintain tracking in urban environment in static and dynamic scenarios including attenuation, momentary satellite outage or jamming. However, there are also shortcomings, i.e. the sensitivity of the architecture to satellite failures or degraded conditions on a channel: one faulty channel will contaminate the whole solution and may lead to receiver instability or loss of all satellites.

In order to take benefits of VTL architecture for integrity application like autonomous vehicle, overall robustness of the architecture needs to be improved along two main axes:

- <u>Deep Coupling with inertial sensors and other sensors (accelerometers, odometer, …)</u>
  'Deep' coupling, as opposed to 'loose' and 'tight' coupling, implement feedbacks from inertial sensors into GNSS signal tracking directly. The objective is to provide very high robustness against noise-like interference in the tracking loops of the receivers and coasting through GNSS outages in urban canyons or under canopy.
- <u>Robustness of the VTL architecture</u>

Several individual aspects have been studied but never consolidated in a single integrated VTL architecture. It is therefore proposed to study several type of additional detectors and integrity monitoring functions to be integrated in a VTL architecture:

- Adaptation of RAIM concept to VTL architecture
- Detectors based on correlator or discriminator outputs
- Adaptive VTL architecture including fault detection (Multipath, Non-Line-Of-Sight [NLOS])
- Multipath and NLOS detection and mitigation
- Detection and isolation of channels contaminated by interferences

The objective of the proposed activity is to design and demonstrate in urban areas a Software Defined Receiver proof-of-concept, implementing a Deeply Coupled Vector Tracking Loop architecture including:

- Deep Coupling with external sensors (inertial, odometer,….)
- Fault detection and isolation strategy to ensure integrity in urban environments against satellite errors, multipath, NLOS and interferences
- Multi-GNSS support to counter balance the exclusion of faulty LoS in already non favorable observability conditions (urban canyons).

The tasks to be performed will include:

- Review of State-of-the-art for the most suitable strategy for inertial coupling with the different possible VTL architecture
- Selection of the architecture and identification of the threats needing specific detectors
- Design of the inertial coupling system
- Design of VTL-Detectors and VTL-RAIM functions
- Implementation and integration in a Software Defined Receiver
- Experimentations to demonstrate the achieved protection levels and robustness in real and simulated environment
- Conclusions on the feasibility, benefits and drawbacks of the proposed architecture. Identification of future work to improve the solution (modelled errors, additional detectors)

The main outputs of the activity will consist of a proof-of-concept of a robust VTL architecture demonstrated in laboratory and in real environment (urban canyons).

This proof-of-concept, focused on autonomous vehicle in urban area, can then be reused as a starting point of next studies in other application domain.

Funding required: 600k€	*Duration:* 16 months	*ITT issue:* Q1 2022

4.3.2. NAVISP-EL1-067: Precision Agriculture - High precision

coordinate and alignments transfer

In future precision agriculture, it is expected that each plant (e.g. corn) will get coordinates with very high accuracy. The type of plants and their coordinates will be stored in a database with additional agricultural information. Therefore, already during the sowing process each finger of the seeder comb/seed drill has to be coordinated with high accuracy in the relevant navigation reference frame. On the tractor usually a dual frequency multi-system professional GNSS receiver with differential corrections is used (e.g. RTK, PPP, N-RTK, etc..). Some of the systems may have also a MEMS or microOptic based inertial measuring unit. In order to avoid the cost for an additional high end package for the each farming tool (e.g. seeder), it could be possible to determine coordinates on the seeder by a typical lever arm solution, e.g. determining the transfer attitude (transfer alignment) by an integration of visual and inertial sensors and gyro based system making use of the known linear dimensions of the farming tool (e.g. seeder). Because the drawbar has a certain tolerance in the trailer hitch, an additional distance sensor (laser, ultra-sound) must be implemented.

The problem is not only applicable to the tractor and farming tool configuration but also to other land machines, and more generally, to machine control (e.g. civil works) or to constrain and steer large mechanical ensemble (e.g. machinery on civil works or even for satellites).

The objective of the activity is to develop a relative high precision PNT-Attitude determination and transfer alignment system to determine each point of a mechanical ensemble. The study will define a generic model for the use of sensor fusion in the control of a mechanical ensemble, in particular machine control use cases, and then tailor it and demonstrate an extremely accurate solution for Precision Agriculture (seeder comb with accuracy of +/- 5 mm 95% TBC).

The tasks to be performed will include:

- Assessment of state-of-the-art PNT technologies and products considered in machine control and precision agriculture (high accuracy positioning, attitude determination, non-GNSS sensors such as INS, radar, vision, etc.) and consolidation of the use cases;
- Mathematical description and modelling of the mechanical ensembles to control, accounting for their kinematic motion;
- Preliminary design and trade-off of candidate solutions (e.g. Kalman filter), considering the mathematical models, available and potential sensors (CCD ultra-sound, radars, etc.), targeted requirements (absolute and relative position, attitude, exposure to vibration, etc.). The trade-offs will also consider the challenges relating to the synchronisation of the various sensors and of the targeted application (e.g. machine control, sowing process, etc.). Simulation of achievable performances tailored to relevant and representative use cases;
- Tailoring to the solution to Precision Agriculture (sowing process and seed comb), with the development of a breadboard and its demonstration in field

trials (involving field work);

- Testing and performance evaluation.

The main output of the activity will consist of:

- the generic solution of the relative kinematic attitude and coordinates determination problem, and its tailoring to Precision Agriculture;
- the development of a Precision Agriculture breadboard and its testing in the field.

Funding required: 300k€	*Duration:* 12 months	*ITT issue:* Q2 2022

4.3.3. NAVISP-EL1-068: Biosensor and PNT Integration

Biosensors (pioneered by C. Clark, inventor of Clark Oxygen Electrode for blood), are sensors that integrate a biological element with a physiochemical transducer to produce an electronic signal proportional to a single analyte which is then conveyed to a detector.

A wide field of applications exists: clinical (in vivo, in vitro) and non-clinical. Typical application fields are food-analyses (e.g. freshness sensor, artificial nose,..), drug development, crime detection, medical diagnosis (clinical and laboratory), environmental field monitoring, quality control, industrial process control, detection systems for biological agents (not limited to warfare), manufacturing of pharmaceutical and human organs, medical event monitoring and testing.
This raises the question about the added value of integrating Biosensors with a PNT function, e.g. in an Internet of Things (IoT) approach. Potentially interesting is the use of the “Lab-on-a-Chip” concept.

Several examples exist already: Digital Angel, Ring Sensor, Smart Shirt, Smart Spacesuit (NASA) EVA, quality and performance testing in sport (Athletics, racing horses, monitoring of soldiers, fire-fighters).

The objective of the proposed activity is to analyse different categories of biosensors and analyse the integration potential with PNT, bringing together at least two scientific groups: Bioengineers and PNT engineers.

The tasks to be performed will include:

- Elaboration of an overview on Biosensors;

- Selection of Biosensors, which could have a promising interface to PNT;
- Engineering level discussion, e.g. integration of Lab-on-Chip with IoT GNSS sensor;
- Identification of current and future application fields, e.g. automatized drug or antigen testing;
- Market analyses and suggestion on viable biosensor & PNT integrated applications.

The main outputs of the activity will consist of:

- Study report: Fundamental assessment of this interdisciplinary application field. Identification of new application fields and technical developments;
- Identification of use cases and new applications

Funding required: 200k€	*Duration:* 18 months	*ITT issue:* Q2 2022

4.4. Lunar activities

4.4.1. NAVISP-EL1-069: Enabling high performance PNT in lunar environment

In the context of the renewed interest in lunar exploration, the need for preparing the future user instrument for the new positioning service on the Moon has become very important, in particular for supplementing the current navigation techniques based on inertial sensors and cameras. A significant R&D effort is ongoing towards the development of dedicated lunar infrastructures for enhanced Moon PNT services. The use of 1-way GNSS-like technologies, in particular, is being proposed by Europe throughout the Moonlight/LCNS system initiative. While preparing for the system development, the user equipment side shall be assessed in detail and innovative concepts introduced. In this context, it is of high interest to understand in detail how Moon users could optimally combine the availability of a new GNSS-like dedicated orbiting system (Moonlight) with inertial and visual sensors planned lunar technologies. The synergies between these sensor technologies for lunar PNT applications is recognized as a priority research area, with a very high potential to achieve absolute metre-level accuracies on the Moon, compared to the currently achievable 200 m with Earth ranging or relative navigation on the Moon's surface.

The ongoing NAVISP EL1-026 and the Moonlight Phase A/B1 study outcomes, at the appropriate development stage, will provide a solid starting point in terms of results and lessons-learned on sensor fusion for lunar applications.

The objectives of the proposed activity are to study, develop and demonstrate innovative PNT techniques at user level for navigation in the lunar environment, combining processing techniques exploiting common sensors adopted on Moon rovers/landers today with the potential future ranging signals from LCNS. Additionally, the activity aims to provide a detailed assessment of the tangible benefits provided by the high performance PNT solution for representative lunar users, such as rovers prospecting for lunar resources and landers aiming for the peaks of eternal light.

The tasks to be performed will include:

- research on the sensor fusion technique for lunar users:
    - o Implementation of navigation techniques with LCNS, using therefore a minimum of one received satellite signal;
    - o Integration of LCNS navigation with other lunar navigation techniques, like Celestial, Inertial and Visual Navigation;
- investigate the following building block.
    - o literature review, assessment of the state of the art and consolidation of requirements for the targeted use cases;
    - o Identification of promising concepts at user level: architecture and algorithms for the aforementioned building blocks and consolidation of the design (with, potentially, combination of multiple concepts);
    - o implementation of the outcome of the Study into an actual processing on a representative platform;
    - o assessment of the performance in realistic Moon scenarios using mock-ups on Earth and utilizing a subset of GNSS signals to simulate LCNS.

The main outputs of the activity will consist of:

- Data package (reports, algorithms, demonstration results, etc.) providing a complete understanding of achievable capabilities of positioning performances;
- Demonstrator breadboard targeting TRL 4.

Funding required: 600k€	*Duration:* 18 months	*ITT issue:* Q3 2022

4.5. Test benches

4.5.1. NAVISP-EL1-070: Advanced MEOSAR Test Beacon Setup

The location methods used in the MEOSAR systems are sensitive to beacon motion. A lot of work has been undertaken during the past years to elaborate test means in order to evaluate the MEOSAR location performance with moving beacons (use of vehicles, drones, turn-style mechanism, beacons of opportunity). The test means used have several drawbacks: limited test time, limited speed range, reliability and/or transportability. With this activity it is planned to develop a solution based on a Digital Beam Forming Network (DBFN) antenna that would be a static system able to emulate any kind of beacon motion (by transmitting signals with different frequency/delay in each satellite direction). Such a system could be used for testing and/or commissioning of existing or future Cospas/Sarsat MEOSAR services.

The test beacon setup will work as a classical one with the possibility to program test scenario including: transmission time, message content, transmitted power, transmitted frequency, waveforms parameters, etc.

As this system will not contain mechanical parts, its maintenance will be easier and cheaper than mechanical systems. It will open the door to the introduction of moving reference beacons for monitoring the quality of MEOSAR services: the system could be used continuously to check the location performance of test beacons with various range of motions.

The objectives of the proposed activity are to develop an Advanced MEOSAR Test Beacon Setup consisting of DBFN (Digital Beam Forming Network) antenna system and the supporting SW, for MEOSAR testing and performance evaluation, in particular in slow-moving and fast-moving cases and cases with local attenuation and masking.

The tasks to be performed will include:

- design and development of the DBFN antenna, which will manage several links in parallel (one link per satellite). From the scenario defined by the user (which includes a position and motion to be simulated), the supporting SW will calculate for each satellite the shift in transmit frequency (to emulate different Doppler), in transmit time (for different time of arrival – TOA) and in power (for local masks and attenuation, which may be useful to evaluate the performance in canyons or mountainous areas). At the antenna level, the phase law will be defined with respect to the satellite positions;

- design and development of the related calibration system, that will be associated to the DBFN antenna in order to check that the signals are transmitted in the correct direction.

The main outputs of the activity will consist of:

- demonstrator of the Advanced MEOSAR Test Beacon Setup and associated calibration equipment;
- associated documentation.

Funding required: 300k€	*Duration:* 18 months	*ITT issue:* Q2 2022

5. SUMMARY

Activity Title	Funding required (k€)	Duration (months)
NAVISP-EL1-063: RIS-aided wireless localization and mapping	500	18
NAVISP-EL1-064: Block-box for an optimised GNSS spectrum monitoring network using AI	450	18
NAVISP-EL1-065: eLoran antenna for handheld devices	250	18
NAVISP-EL1-066: Deeply Coupled GNSS Vector tracking loop robust solution for autonomous vehicle	600	16
NAVISP-EL1-067: Precision Agriculture - High precision coordinate and alignments transfer	300	12
NAVISP-EL1-068: Biosensor and PNT Integration	200	18
NAVISP-EL1-069: Enabling high performance PNT in lunar environment	600	18
NAVISP-EL1-070: Advanced MEOSAR Test Beacon Setup	300	18
Total	3200	

ID	Activity Title	2022				2023				2024			
063	RIS-aided wireless localization and mapping				ITT								
064	Block-box for an optimised GNSS spectrum monitoring network using AI		ITT										
065	eLoran antenna for handheld devices			ITT									
066	Deeply Coupled GNSS Vector tracking loop robust solution for autonomous vehicle	ITT											
067	Precision Agriculture - High precision coordinate and alignments transfer		ITT										
068	Biosensor and PNT Integration		ITT										
069	Enabling high performance PNT in lunar environment			ITT									
070	Advanced MEOSAR Test Beacon Setup		ITT										