

NAVISP

G.Solari
NAVISP Element 1
Head of Office

Why PNT? Ubiquitous Positioning

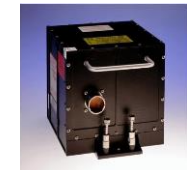
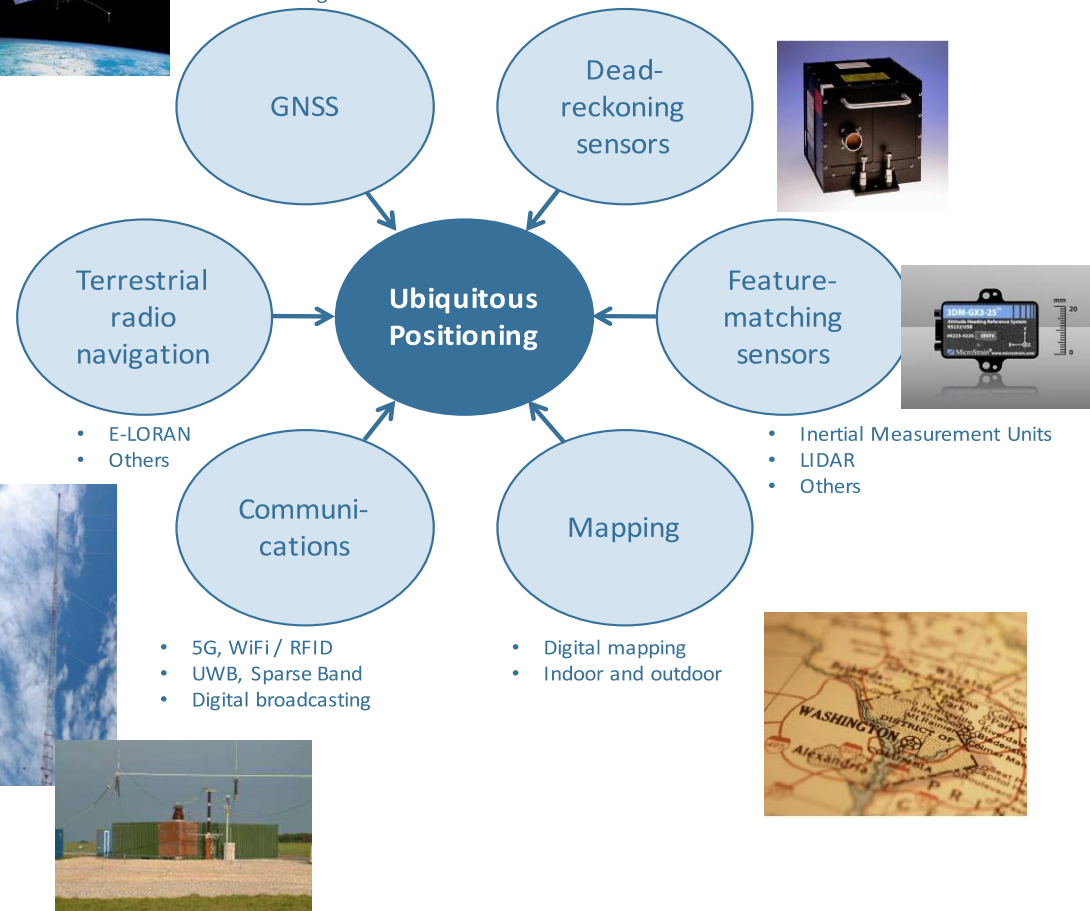
What is Ubiquitous Positioning?

- **Multi-sensor, low-cost and robust positioning**
 - Based on single or multiple users
 - Different types of platforms and sensors
 - Autonomous or cooperative navigation
- **Seamless transition when transitioning between different environments**
 - Different sensors
 - Different platforms
 - Different algorithms
- **Continuous positioning across all environments**
 - Open areas
 - Partially obstructed
 - Indoor



More GNSS satellites
More GNSS signals

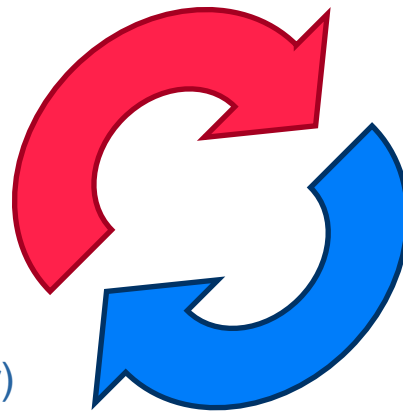
- 3-Dimensional Dead Reckoning



New Technology – New Applications – New Challenges

New technology

- More GNSS satellites
- More GNSS signals
- Communications
- WiFi / RFID*
- UWB, Sparse Band*
- Digital broadcasting*
- Pseudolites, Locatalites
- Smaller, cheaper inertial sensors
- Digital mapping (outdoor & indoor)
- More processing power



Drives new applications

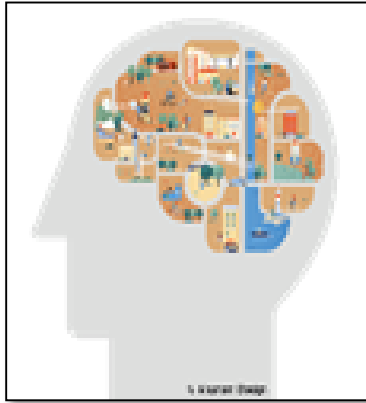
New applications

- Seamless indoor-outdoor personal navigation
- Intelligent Transport Systems
- Rail signalling & control
- Precision aircraft landing
- Ships in harbours
- Location-dependent billing
- Virtual security fences
- Tracking people/animals/assets
- Social inclusion

Creates new challenges

Courtesy of Dr Paul Groves, UCL

PNT Challenges



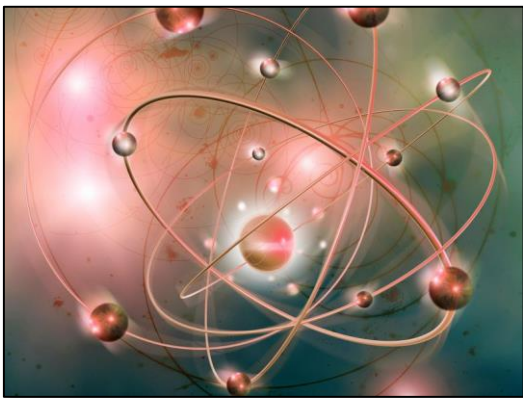
Artificial Intelligence PNT



PNT Innovations



PNT for Autonomy



Quantum PNT



Resilient PNT

*Courtesy of Prof Terry Moore
University of Nottingham*

New concepts for improved PNT Resilience and Robustness

Protect
Toughen
Augment
against PNT Threats



Maritime Jamming Reports



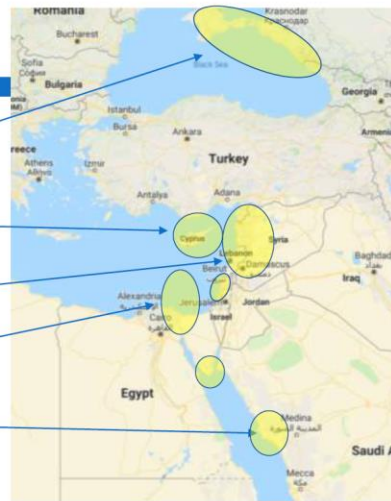
VIP Protection & Conflict

Disrupt Oil/Gas Surveys?

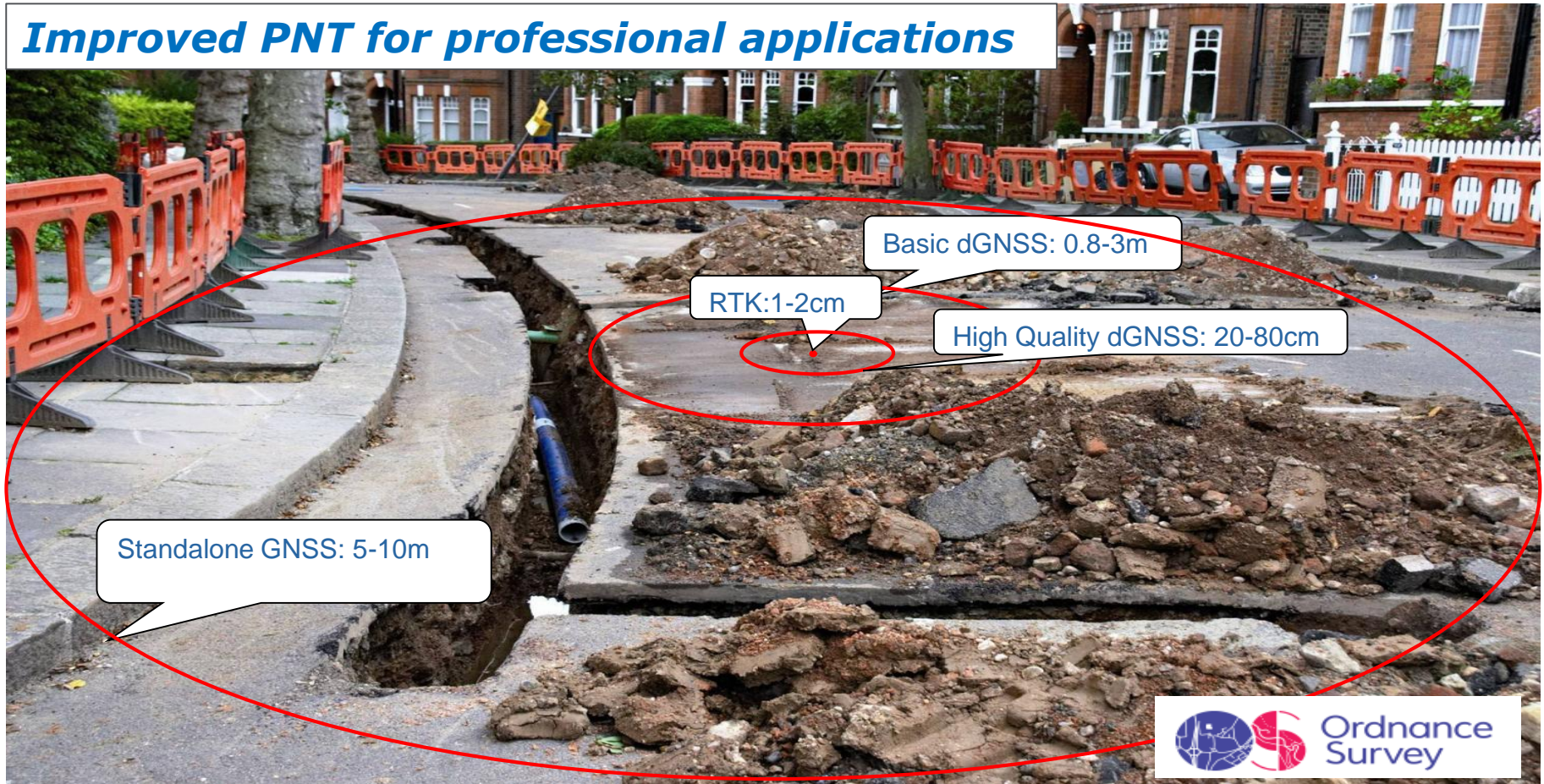
Armed Conflict

Illegal Fishing?

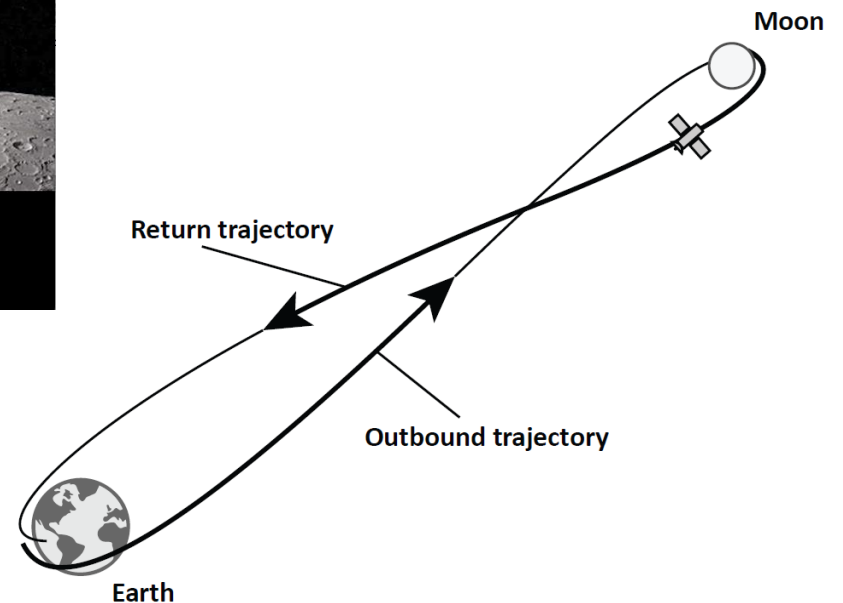
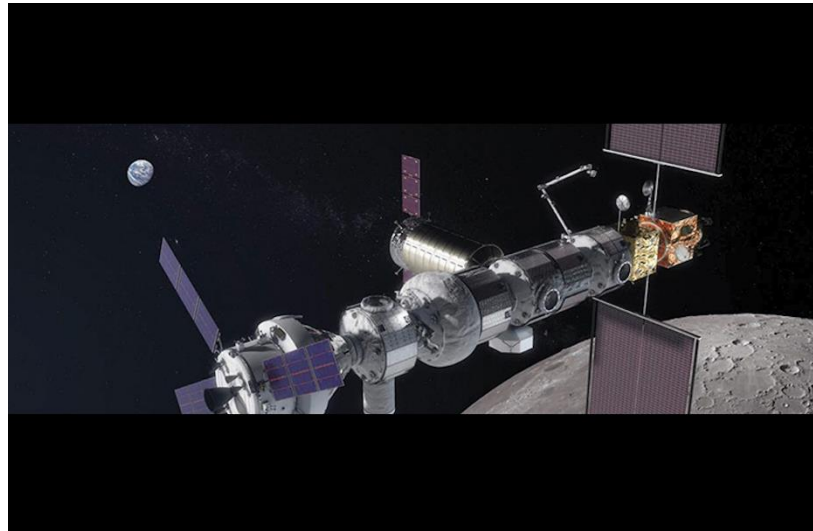
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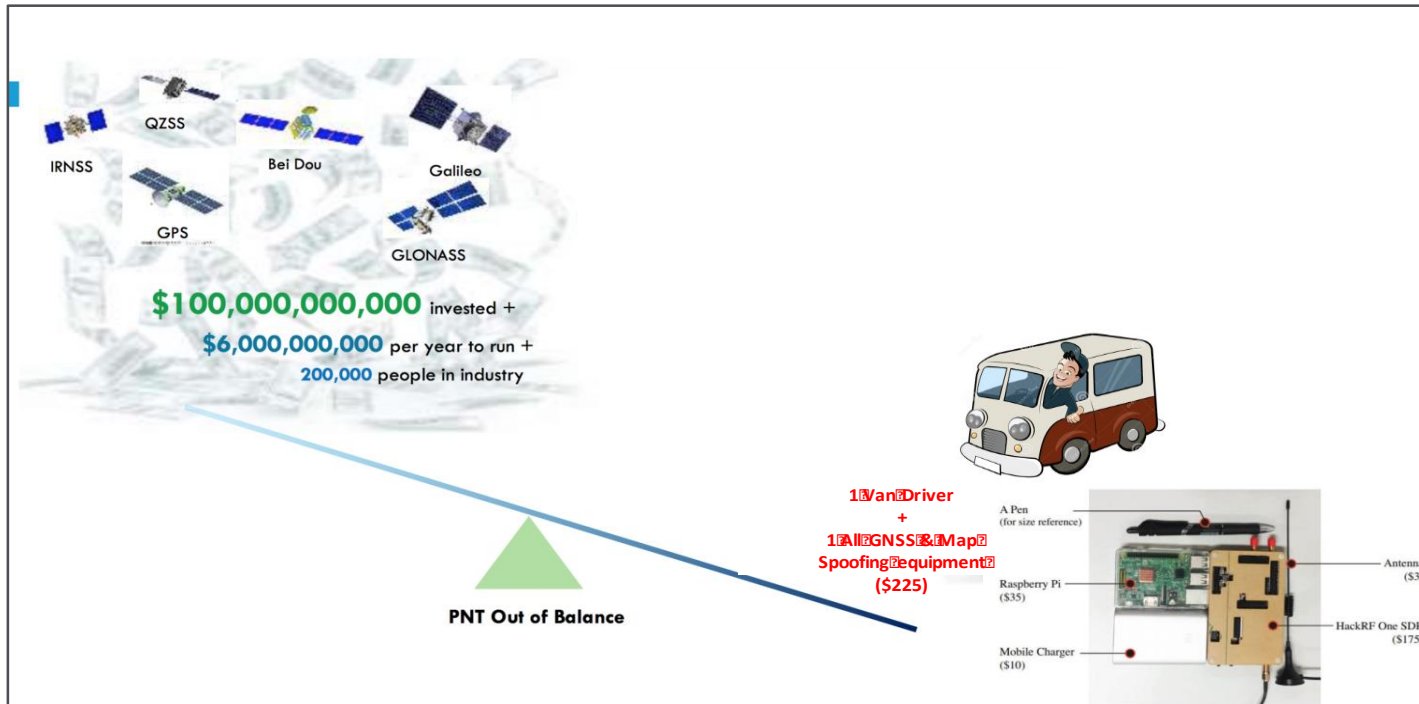
Improved PNT for professional applications



Highly Sensitive Spaceborne PNT Receivers in support of Interplanetary Navigation



PNT unbalance...



NAVISP, the ESA programme designed to foster innovation & competitiveness of the European PNT sector

To leverage these upcoming opportunities, the European PNT sector will need to:

- Develop cutting-edge technologies & effective products & solutions
- Maintain & increase competitiveness of the research and industrial sectors to keep them at par with existing and emerging solutions worldwide

Objectives of NAVISP

- **Improve industrial innovation** and competitiveness at all industrial levels and all industrial sizes, and driving growth and jobs
- **Flexibility for MS** to target investments to support national objectives, under MS control
- Enables ESA MS to invest in developing industrial capacity, e.g. qualify **new entrants for the market**
- Uses best practice in terms of **responsiveness and fast contracting procedures**
- Open for **non-space industry** to capture **the full spectrum of PNT innovation and commercialisation**
- Designed to **avoid any duplication** with work funded by the EU under H2020 or Fundamental Elements

NAVISP The Programme Structure



	ELEMENT 1 [Innovation in Satellite Navigation]	ELEMENT 2 [Competitiveness]	ELEMENT 3 [Support to Member States]
Content	Analyses and developments linked to new and emerging design and operational concepts, techniques and technologies related to satellite navigation systems	Ad hoc technological & product developments and pre-operational activities along the whole satellite navigation value chain in support of the competitiveness of the industrial sector in the participating Member States	Support to MS national Programmes & Activities in satellite navigation and along the whole value chain
General principles for implementation of the activities	Competitive tender, 100% ESA funding on the basis of yearly work-plan adopted by PB NAV	Continuous open call, unsolicited proposals, ESA co-funding (level of support to vary according to TRL level), MS support letter	On request by MS, ad-hoc mechanism to be established on a case-by-case basis that ensures ESA's full costs are met
Lead for the definition of the activities	ESA	Industry	Member States



Contribution to the financial envelope covering NAVISP phase 1:

Participating States	Element 1 M€, 2016 e.c.	Element 2 M€, 2016 e.c.	Element 3 M€, 2016 e.c.	Total M€, 2016 e.c.
Austria	0.40	1.40	-	1.80
Belgium	0.50	-	1.48	1.98
Czech Republic	1.00	1.00	0.20	2.20
Denmark	0.50	0.50	0.50	1.50
Finland	1.15	0.50	0.28	1.93
France	2.00	4.00	-	6.00
Germany	2.63	2.63	-	5.26
Ireland	-	1.00	-	1.00
Italy	-	2.50	-	2.50
Netherlands	0.50	0.50	-	1.00
Norway	0.70	2.00	2.30	5.00
Poland	-	2.10	-	2.10
Portugal	-	1.00	-	1.00
Romania	0.67	0.67	0.67	2.01
Spain	-	6.00	-	6.00
Sweden	-	0.71	-	0.71
Switzerland	0.98	1.52	-	2.50
United Kingdom	5.00	20.00	5.00	30.00
Canada		2.00		2.00
Covered	16.03	50.03	10.43	76.49
Uncovered	17.47	9.97	23.07	50.51
TOTAL	33.50	60.00	33.5	127.00

NAVISP Element 1: launched activities

		WP17	WP18	Addendum to WP18
THEME 1	Emerging New Space-based PNT Concepts	<ul style="list-style-type: none"> Complementary PNT Infrastructure in LEO Trusted Radionavigation via Two-Way Ranging 	<ul style="list-style-type: none"> Resilient, Trustworthy, Ubiquitous Time Transfer High-Altitude Pseudo-Satellites for PNT Quantum-based sensing for PNT PNT using Neutrino Particles Design and practical aspects of a space-based relativistic PNT system 	Not applicable
THEME 2	Innovative Use of Space-based Solutions in the PNT Context	<ul style="list-style-type: none"> System Suitability Study for Train Positioning Using GNSS in ERTMS in 2020 Multi-System Multi-Sensor Maritime PNT Test Equipment Multipath & Interference Error Mitigation Techniques for Future Maritime e-NAV Services 	<ul style="list-style-type: none"> GNSS/non-GNSS Sensor Fusion for Resilience in High Integrity Aviation Applications Techniques supporting Resilience for High Integrity Train Control Applications 	Not applicable
THEME 3	Proof of Concept of Promising PNT Techniques and Technologies	<ul style="list-style-type: none"> Pulsar Timescale Demonstration Cooperative Navigation and Cloud Processing Weather Monitoring Based on Collaborative Crowdsourcing Space GNSS Receiver for In-Orbit Demonstration of PPP Low-Cost GNSS Antenna Arrays for Improved Performance, Anti-Spoofing, etc. 	<ul style="list-style-type: none"> Low-RF Fast Deployable Systems for Emergencies in Difficult Environments Ultra-Low Power Device Positioning Concepts Artificial Intelligence / Machine Learning Sensor Fusion for Autonomous Vessel Navigation Integrity Monitoring and Prediction Concept for Autonomous Car Resilience and Safety Low cost multi-frequency multi-constellation GNSS antenna for CubeSats 	<ul style="list-style-type: none"> Earth-Moon Navigation / System Study and Development of a Highly-Sensitive Spaceborne Receiver Prototype Precise Relative Positioning in MEO to support Science Missions Multi-Sensor, Multi-System for Space PNT Applications Enabling Ultra-High Accuracy Positioning in Challenging Environment
Total budget (€M)		4.6	3.9	2.0

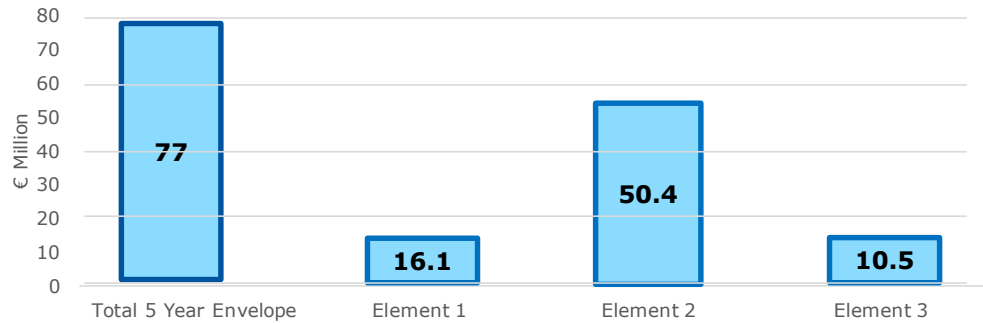
2019 NAVISP Element 1 Work Plan

List of Approved Activities

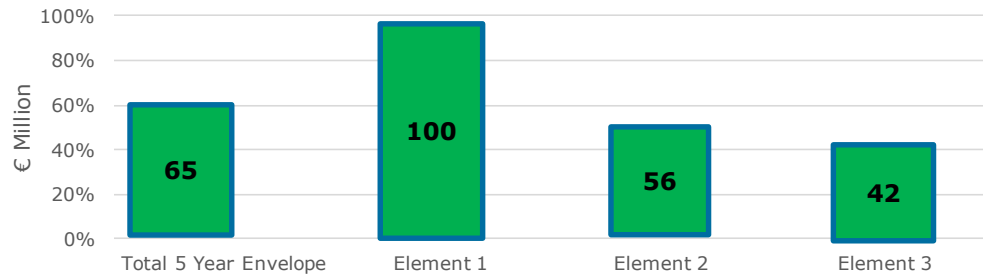
THEME 1
Alternative Space-based PNT Data Layer
THEME 2
GNSS science with commercial aircraft
THEME 3
Collaborative Processing of Distributed Receivers of Opportunity for Jamming and Spoofing Mitigation
Advanced Multi-Frequency low-cost high-gain GNSS antennas for next generation of mass-market devices
Precise Timing for Indoor Small Cells
Advanced concept for chip-scale atomic clocks
Antenna and Transponder Unit for Underwater PNT
AI-enabled baseband algorithms for High Fidelity Measurements
Machine Learning to model GNSS systems
Precise positioning for mass-market: optimal data dissemination demonstrator
PNT Timing & Synchronisation for Aviation Systems and Networks

NAVISP Status

Subscriptions (e.c.2018) and percentages



Budget of Incubated Activities as % of Total



∞ 65% of the subscribed envelope already booked at 40% of NAVISP lifetime

NAVISP is off to a great start

- WP's for Element 1 2017, 2018 and Addendum are being implemented: 19 contracts already awarded for a total of 39 approved activities including WP2019
- Element 2 activities have been incubated at a very fast pace together with several Member States and key European PNT stakeholder for a total of 50 activities
- Element 3 has also been rapidly implemented since recent kick off
- 65% of the total available funds already engaged
- Several NAVISP activities very much linked to the broader PNT sector and partnerships with new non-space entrants

NAVISP motivation to participate



- The Programme is managed with **15% of overhead**
- **IPR remains with the Contractor**
- All information is treated **as commercial sensitive**
- **Transferable product ownership** upon contract completion
- **ESA partnering and facilitating the procurement and execution**



- **Further MS's subscriptions** to NAVISP are already materialising:
 - New Participant States, with Germany that joined in Q3 2018
 - Increase of subscribed amount, e.g. Poland
- **A High-Level NAVISP Advisory Committee (NAVAC)** has been set-up to support the programme with external expert advice

- NAVISP aims to foster innovation on the PNT field while supporting industry and member states interests.
- NAVISP portfolio of activities is quite heterogeneous: mix of ESA-driven, industry-driven initiatives, namely bottom-up in an attempt to capture the broad scope of NAVISP.
- Is the NAVIPS portfolio complete? Is it meeting the needs of an evolving and highly competitive PNT market?
- An advisory committee of high-profile experts has been set up to provide an **external** view to help ESA in answering the above questions.
 - NAVAC: **NAV**igation Innovation and Support Programme **A**dvisory **C**ommittee

NAVAC Composition

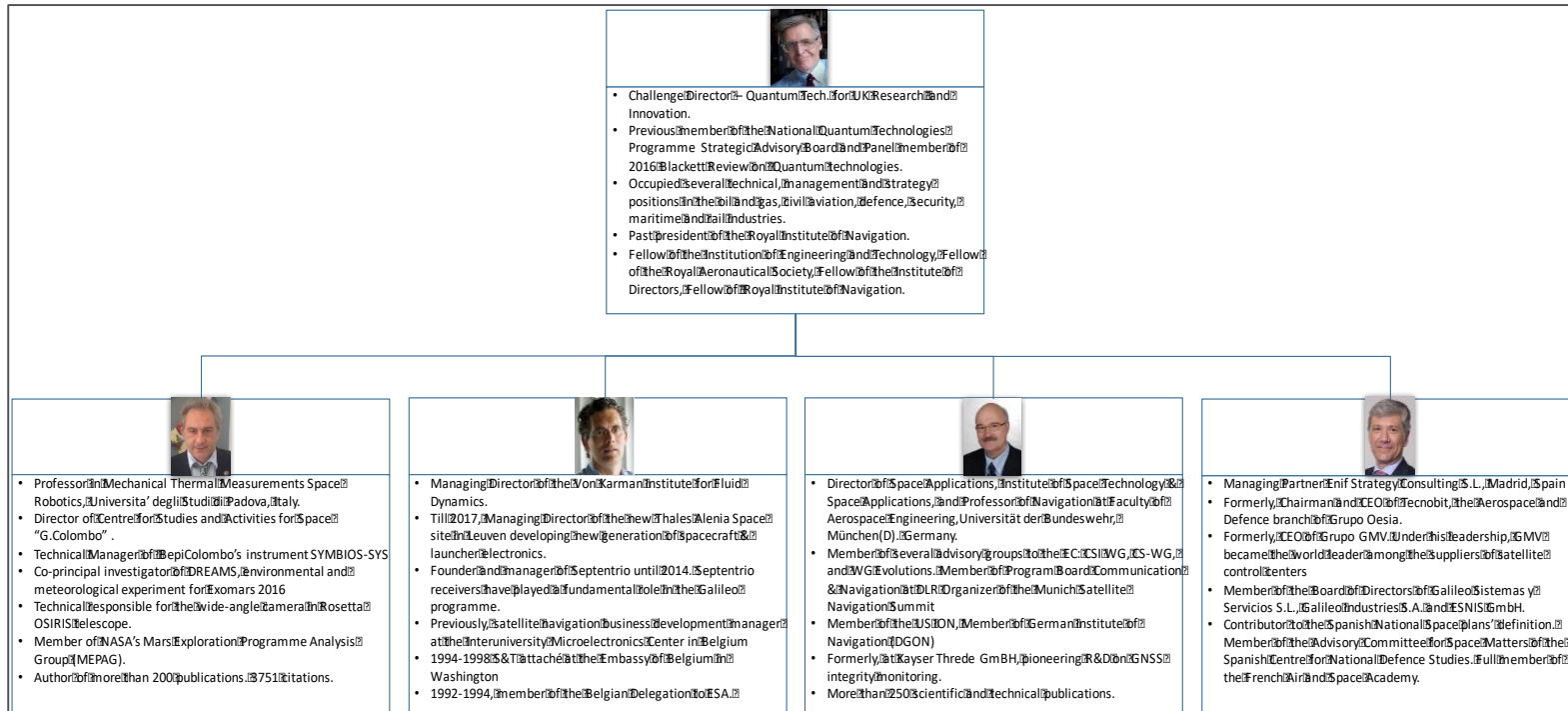


- 5 members appointed in Sept 2018:

Roger Mc Kinlay	Chair
Stefano Debei	Member
Peter Grogard	Member
Bernd Eissfeller	Member
Luis Mayo	Member

- NAVAC Secretariat provided by ESA: Rafael Lucas





- NAVISP Element 1 WP2019 comments:
 - Portfolio of activities supported
- Recommendations for future WPs:
 - Increase of activities portfolio addressing integration of space/non space sensors
 - Strengthen link between use-cases and proposed solutions
 - Acceleration of schedule in Proof-of-Concept projects
 - Cross linking of activities results
- Evaluation of achievements of NAVISP phase I by mid 2019 in support of NAVISP phase II programme proposal preparation

- Outreach events:
 - participation/presentation of NAVISP in many fora
 - dedicated national workshops
 - NAVISP industry days

- Other outreach activities:
 - operational website: <https://navisp.esa.int>
 - flyers
 - video

NAVISP Industry Days

NAVISP
 Innovation
 Competitiveness
 Support to Member States

esa
 European Space Agency

SAVE THE DATES:
NAVISP INDUSTRY DAYS
January 17 – 18, 2019
At ESTEC – The Netherlands

PNT
 Positioning, Navigation, Timing

European Space Agency



NAVISP INDUSTRY DAYS ESTEC AGENDA

NEWTON 1 '60/ESTEC@ESA
 NEWTON 2 '81/ESTEC@ESA

17 January

14:00
 Welcome (Paul Verhoef/P.Michel)
 NAVISP programme (P. Mancini)
 Keynote Speech (R. Mc Kinlay)

15:15
 Coffee break

15:45
 Element 1 Session: Innovation
 Chair: G. Solari
 Keynote speech on PNT innovation:
 Bernd Eissfeller
 Projects presentations
 Q&A

18:00
 Cocktail

18 January

09:00
 Element 2 Session: Competitiveness
 Chair: A. Fiumara
 Keynote speech: Louis Mayo
 Projects presentations
 Q&A

11:00
 Coffee break

11:30
 Element 3 Session: Support to
 Member States national objectives
 Chair:
 Keynote speech Andy Proctor
 Projects presentations
 Q&A

13:00
 Lunch

14:00
 NAVISP second phase (P.Mancini)
 Conclusions



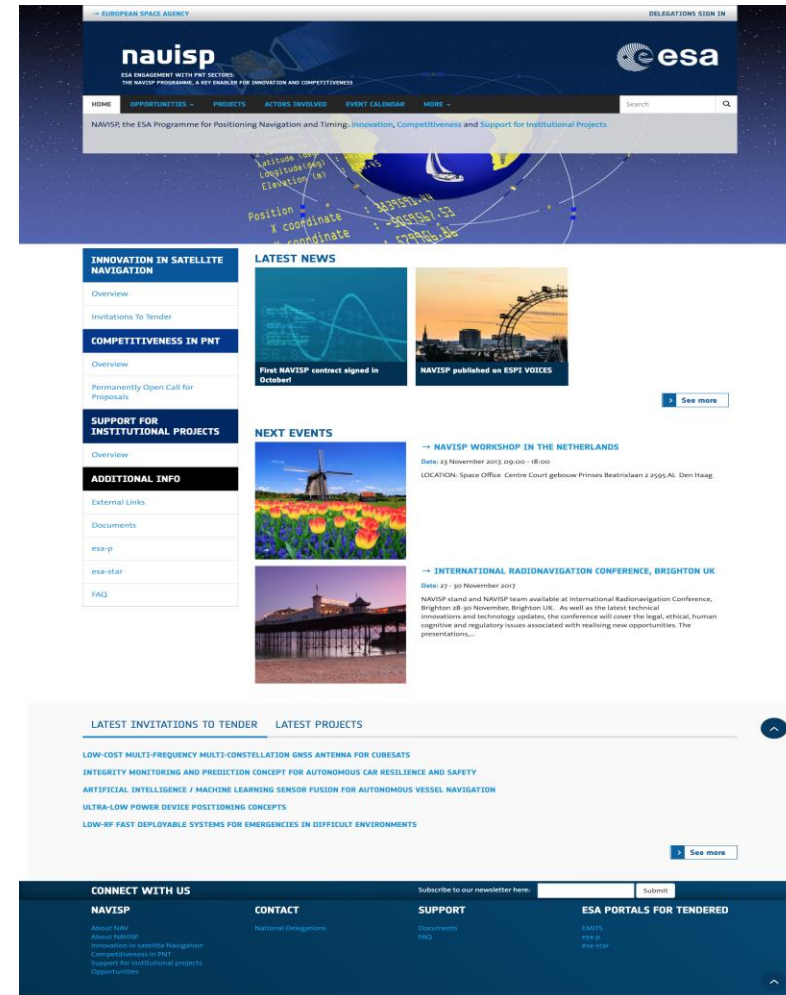
The NAVISP Portal

A web portal serves as a “gateway” to the NAVISP programme.

The goals of this portal is:

- Serve as a ‘notice board’ for NAVISP calls, ITTs, news stories, events, workshops
- Repository of documentation and information / education tool for user
- Promotional tool for NAVISP activities (workplan, on going projects, etc.)
- Promotional tool for NAVISP actors (list of actors involved contacts, etc.)
- A central single entry point (of contact) for all NAVISP

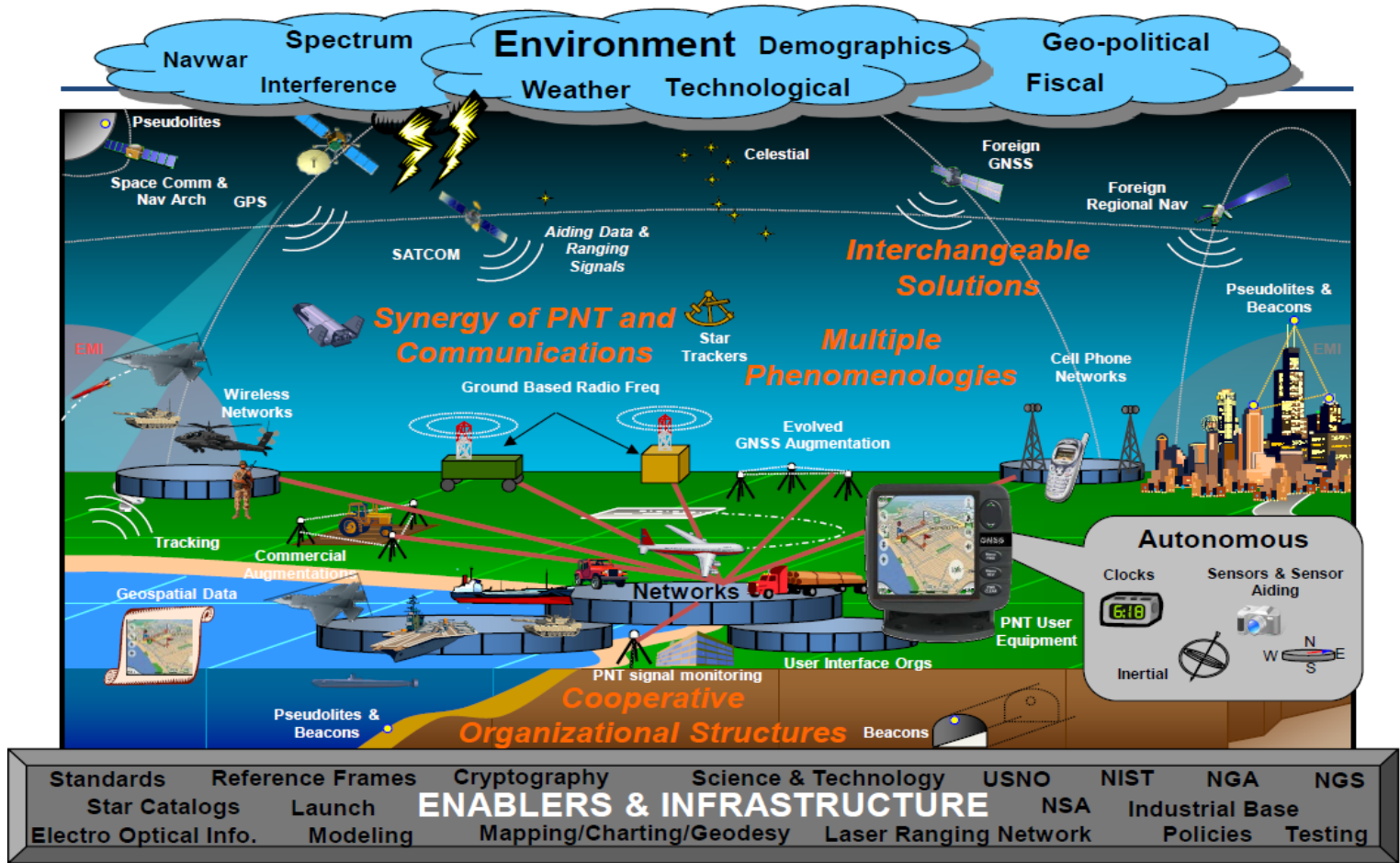
<https://navisp.esa.int>



Solicited by the increasing interest of Member States, ESA is preparing NAVISP Phase II in view of Cmin 2019 doubling the funding request from to 20 to 40 MEuro per year

- 7 Feb PB-NAV 2019: draft Programme Proposal submission
- 8 March 2019 Potential Participants meeting: fine-tuning of the Implementing Rules
- 9 May PB-NAV 2019: Programme Proposal finalisation, Implementing Rules updated and Declaration

Future of Positioning, Navigation, and Timing



Karen Van Dyke
U.S. Department of Transportation