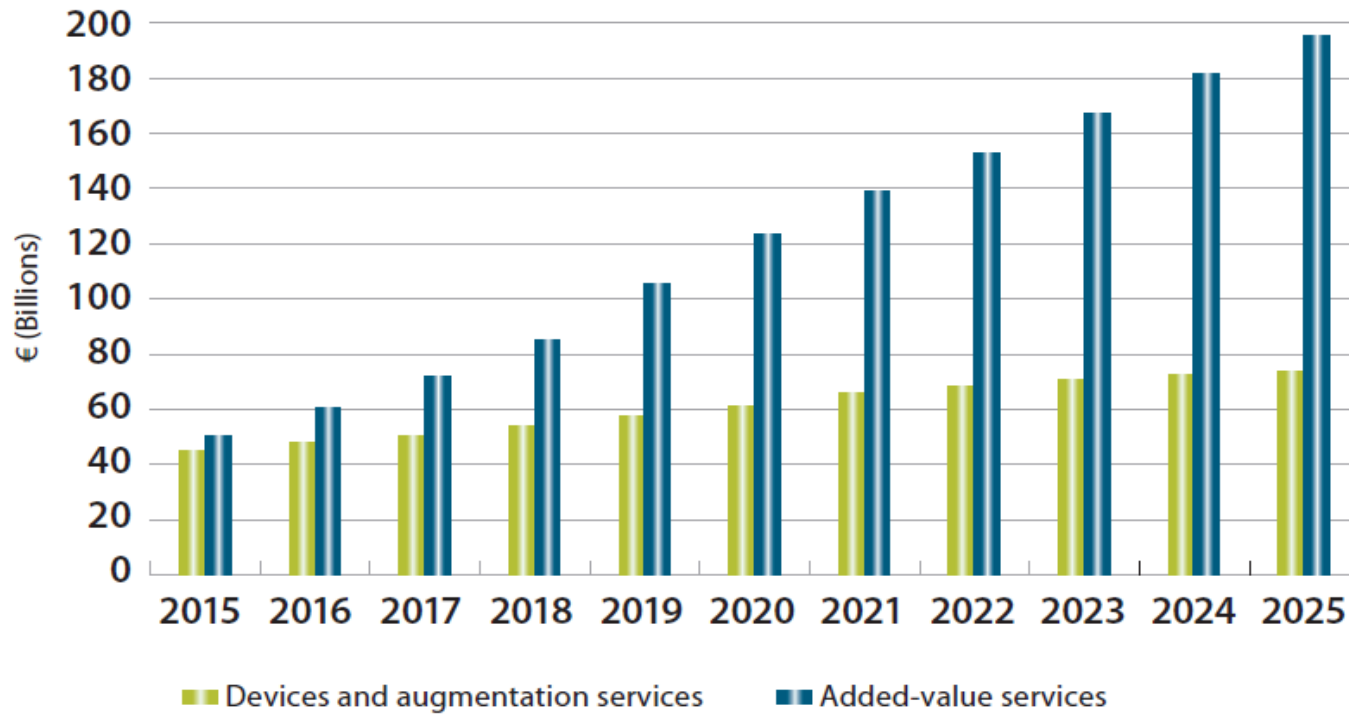


# NAVISP

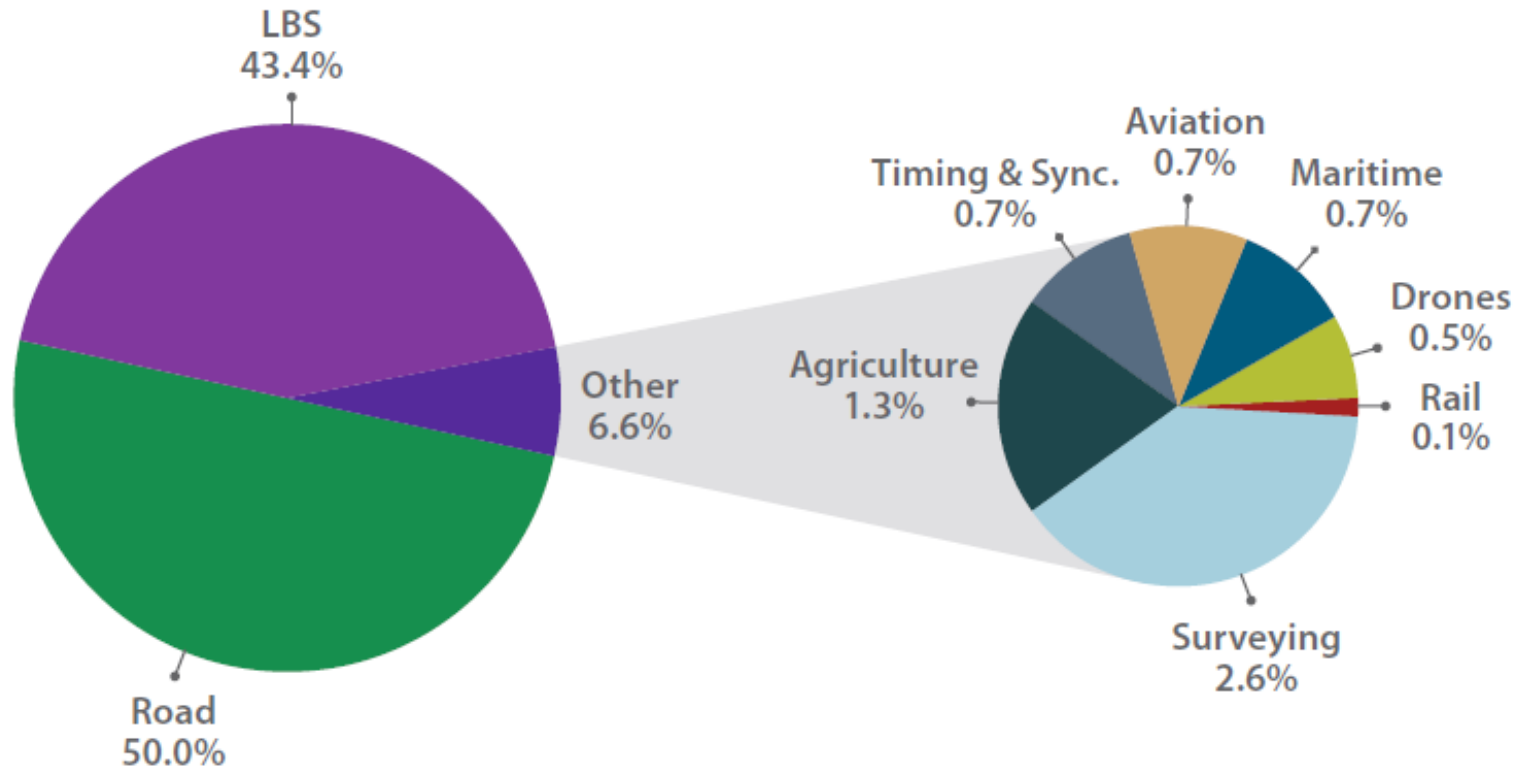
**Dr P.Mancini**  
**NAVISP Programme Manager**

Global revenue by type



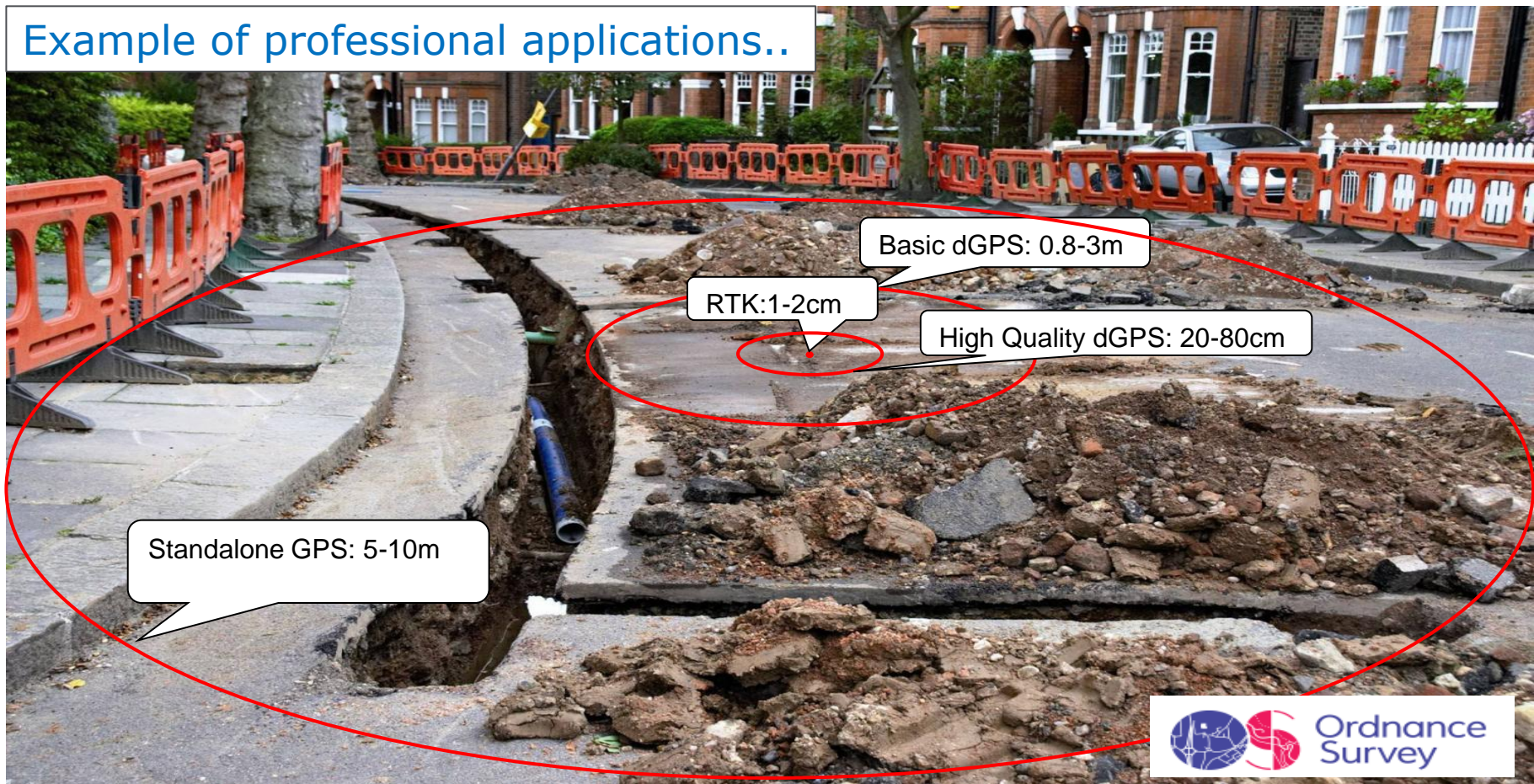
GSA

# Cumulative Revenue 2015-2015 by market segment



GSA

# Example of professional applications..



# The phenomenon of Internet of Things and ubiquitous connectivity and positioning

The digital services marketplace is increasingly connecting industries and facilitating cross-industry applications, services, business models, loyalty programs and advertising.

## Networked consumer electronics

- Embedded mobiles
- Smart homes
- Energy consumption
- Vehicle, asset & pet monitoring



## Networked industries

- Security & surveillance
- Building management
- Agriculture automation
- M2M & wireless sensor network



## Networked society

- Telemedicine & healthcare
- Smart grids
- Smart cities
- Everyday things



**EVERYTHING AND EVERYWHERE CONNECTED AND POSITIONED!**

### Autonomous Cars

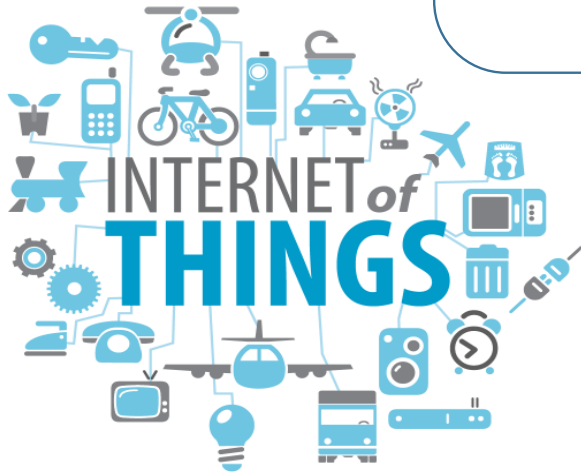
Operation of the vehicle without a human driver. Examples include self-parking cars, motorway assistance, and the transportation of goods by trucks on well-delineated routes

**Intelligent road infrastructures.** Centralised platforms that monitor and control roads, enhancing safety, security, and maintenance. This would also enable quick response to bad weather or road accidents.

**Digital hospital.** Digitise healthcare records and provide remote control of some medical services. Factors like blood pressure and diet can be monitored and made available to a person and their doctor.

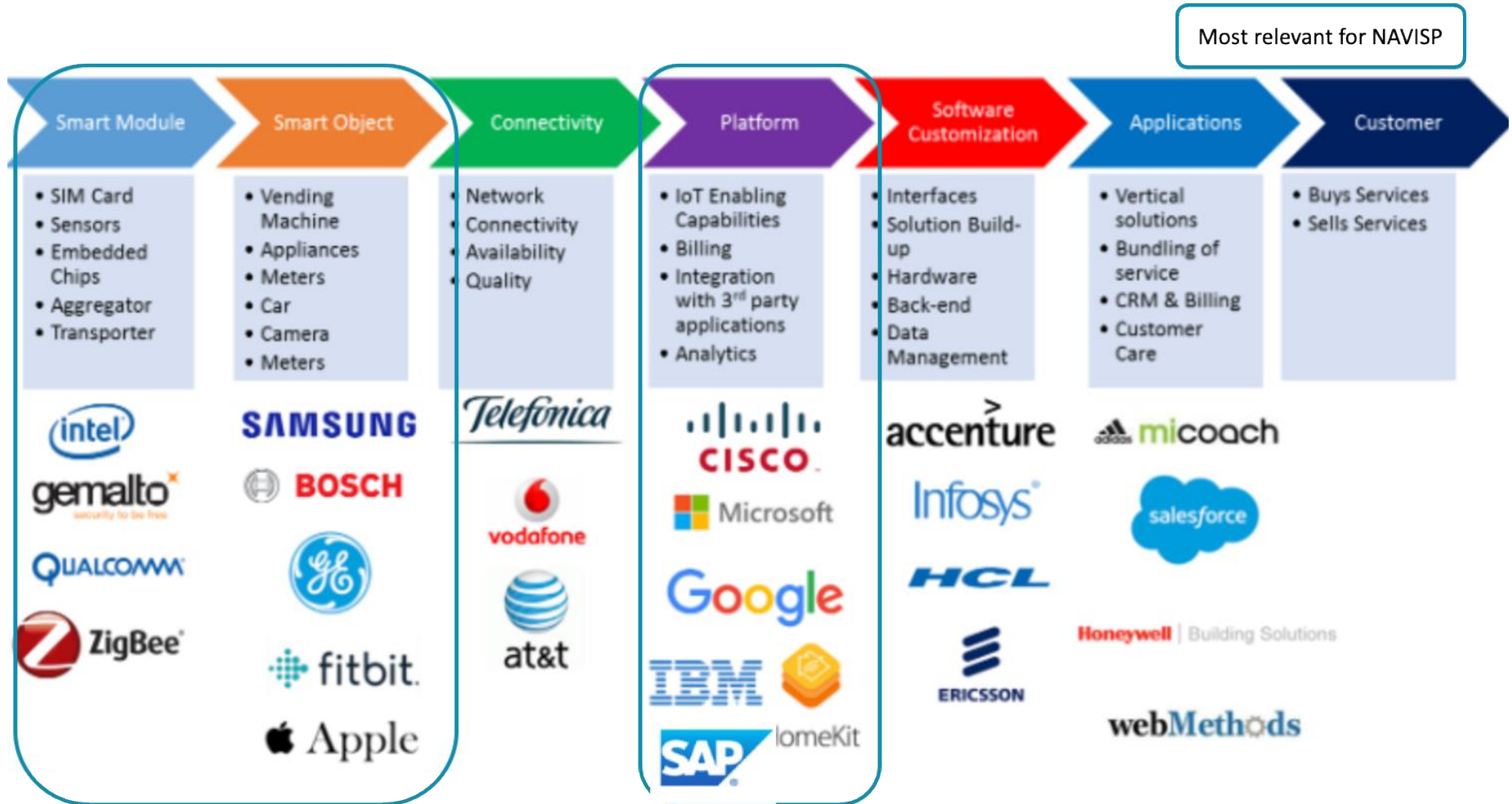
And much more ...

Need to create **service enabling platforms** that operate within a service innovation framework, to **connect** ecosystems, developers, customers and marketplaces.



**1 Trillion Sensors Connected over the Internet by 2022 (WEF)**

# IoT value chain and examples of key players



# Snapshot of the fierce competition in the autonomous car sector

**Car makers**

**Will the Tesla Model 3 be the First Autonomous Car?**  
 GM Invests \$500 Million In Lyft For Self-Driving Car Race With Uber, Tesla And Google

**BMW, Audi, and Mercedes just bought Nokia's Mapping Tech**  
 BMW, Mercedes, and Audi close Nokia Here Maps sale - and your next car could benefit

**Renault-Nissan hires Here exec to develop connected strategy Japanese industry to team on self-driving cars**

**The Chinese BATs (Baidu, Alibaba and Tencent)**

**China's tech giants are getting into the autonomous car business**

**For China's Alibaba, the Magic Word Is "Connected Car"**  
 Alibaba, SAIC Motor To Invest \$160 Million In Connected Cars  
**SAIC to Introduce Alibaba Connected Car in August 2016**

**China's Search Giant Baidu Plans To Build a Robocar**  
 It's Baidu vs. Google in the race to build driverless cars

**Baidu Enters the Global Race for Driverless Car Domination**

**IT Giants**

Google is track-testing fully autonomous cars with no steering wheels or brake pedals, but those remain illegal on public roads. Other carmakers, such as Tesla, with its autopilot mode, and Volvo, with its safe-distance and lane-keeping systems, are already putting semiautonomous vehicles on roadways across America.

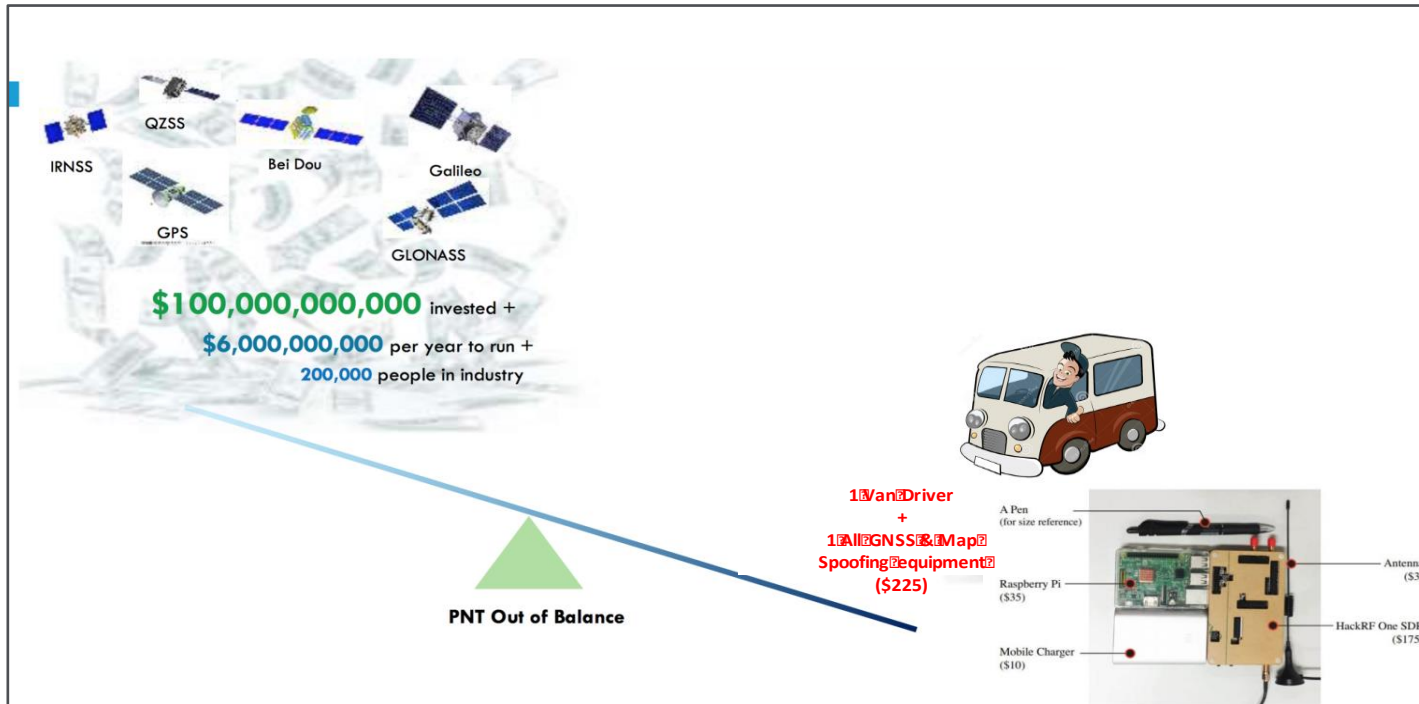
**Apple**  
**iCar release date rumours, features and images:** Apple has tripled its R&D budget to \$10bn suggesting something big is being developed

**Disrupting new entrants: from hackers, to 3D printing, to Supercomputing**

Watson, a computer system that can process and structure data, is a key component of Olli, a self-driving vehicle produced by Local Motors, an Arizona-based company that specializes in 3D-printed vehicles.

**Bloomberg**  
**The First Person to Hack the iPhone Built a Self-Driving Car. In His Garage**  
 George Hotz is talking on Google and Tesla by himself.

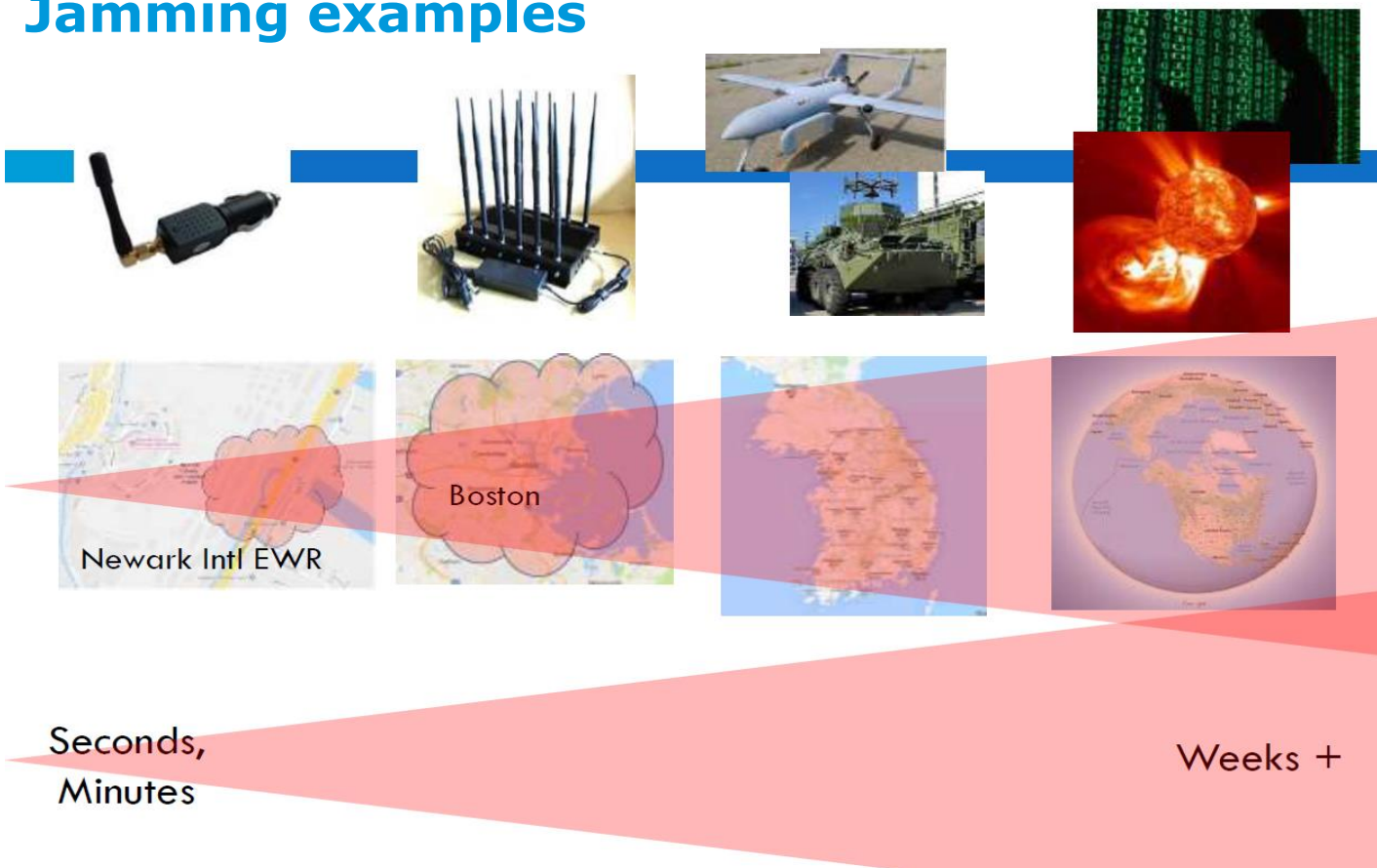
# PNT unbalance...





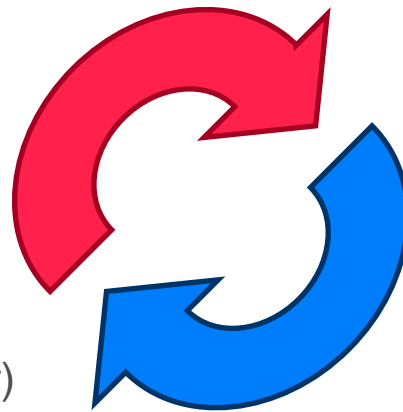


# Jamming examples



## 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



## 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

## Drives new applications

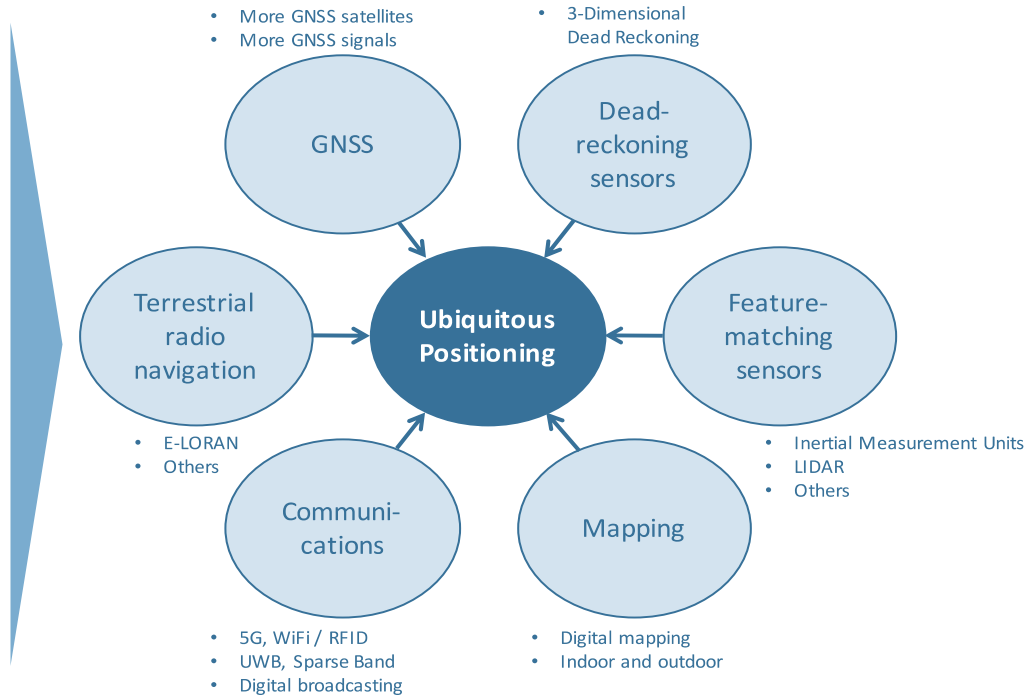
## Creates new challenges

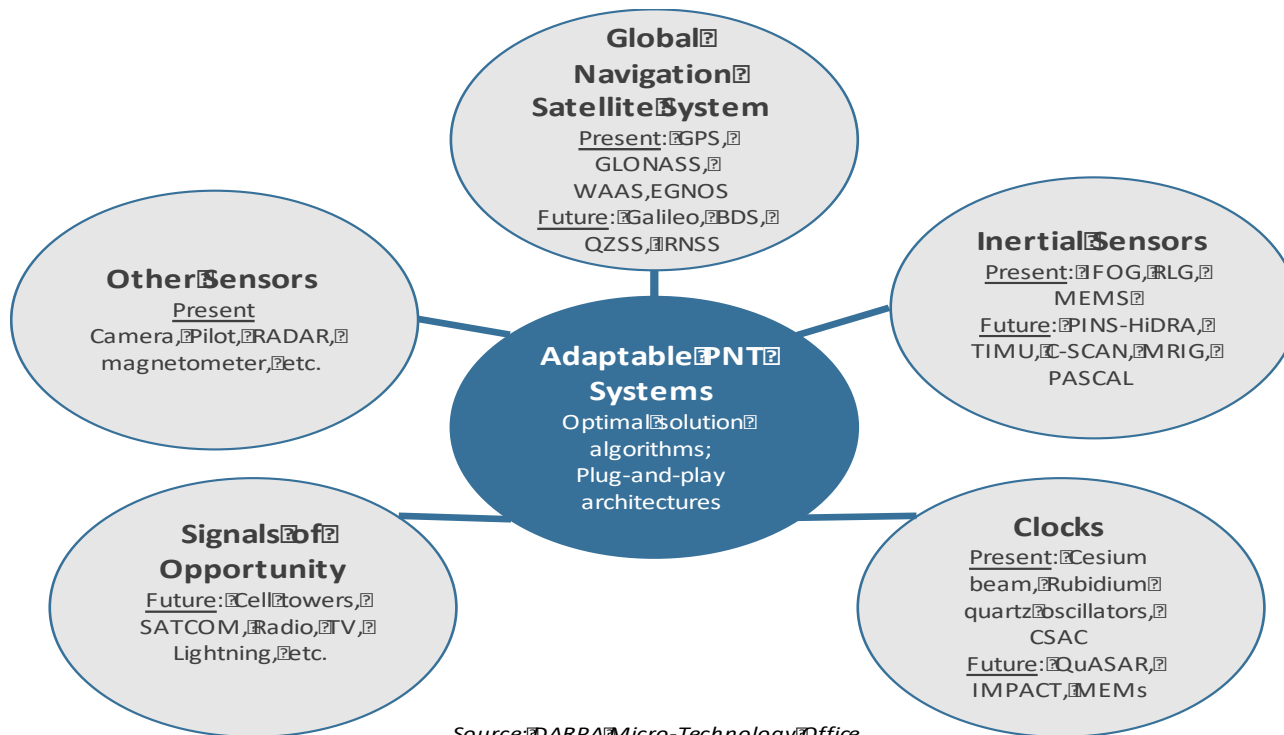
*Courtesy of Dr Paul Groves, UCL*

# 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





Source: DARPA Micro-Technology Office

# 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



	<b>ELEMENT 1</b> [Innovation in Satellite Navigation]	<b>ELEMENT 2</b> [Competitiveness]	<b>ELEMENT 3</b> [Support to Member States]
<b>Content</b>	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
<b>General principles for implementation of the activities</b>	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
<b>Lead for the definition of the activities</b>	<b>ESA</b>	<b>Industry</b>	<b>Member States</b>



## 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
<b>TOTAL</b>	<b>33.50</b>	<b>60.00</b>	<b>33.5</b>	<b>127.00</b>



# NAVISP Element 1: launched activities

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

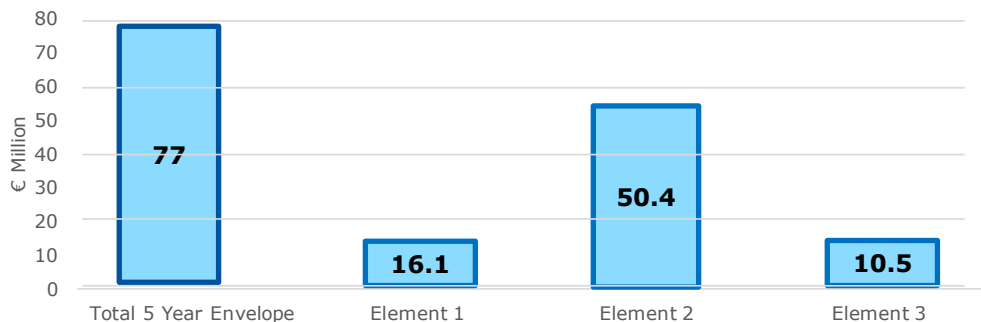
# 2019 NAVISP Element 1 Work Plan

## List of Approved Activities

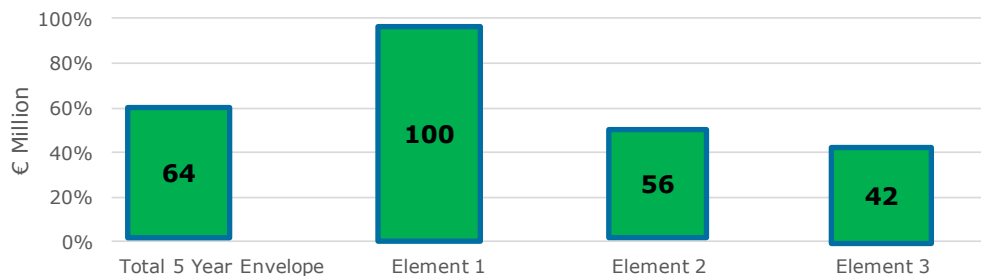
<b>THEME 1</b>
Alternative Space-based PNT Data Layer
<b>THEME 2</b>
GNSS science with commercial aircraft
<b>THEME 3</b>
Collaborative Processing of Distributed Receivers of Opportunity for Jamming and Spoofing Mitigation
Advanced Multi-Frequency low-cost high-gain GNSS antennas for next generation 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



∞ 64% 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



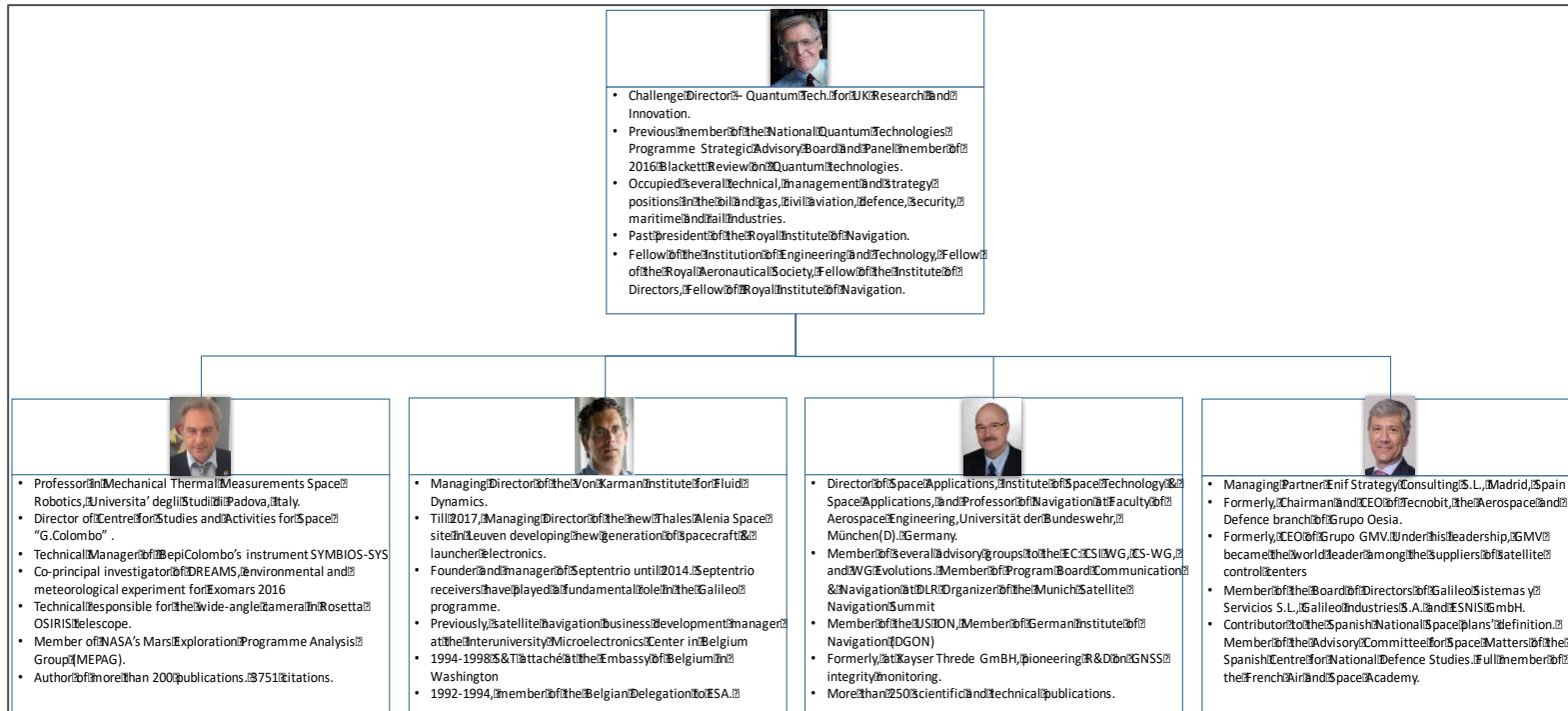
- 5 members appointed in Sept 2018:

<b>Roger Mc Kinlay</b>	Chair
<b>Stefano Debei</b>	Member
<b>Peter Grogard</b>	Member
<b>Bernd Eissfeller</b>	Member
<b>Luis Mayo</b>	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

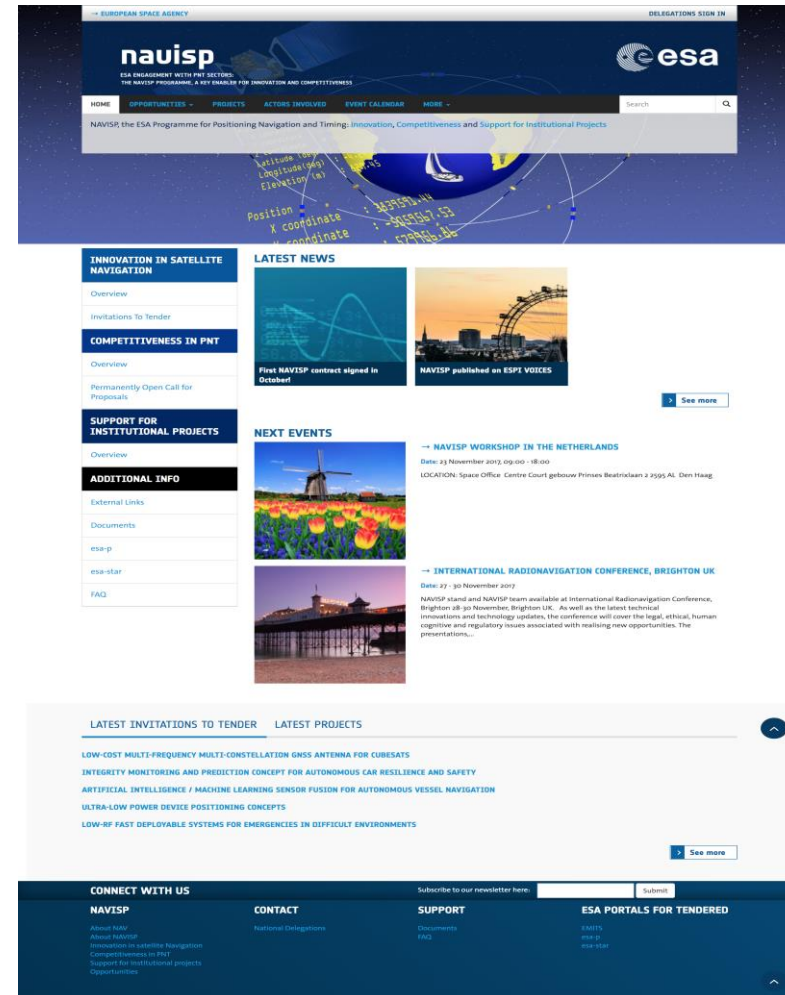
# The NAVISP Portal

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

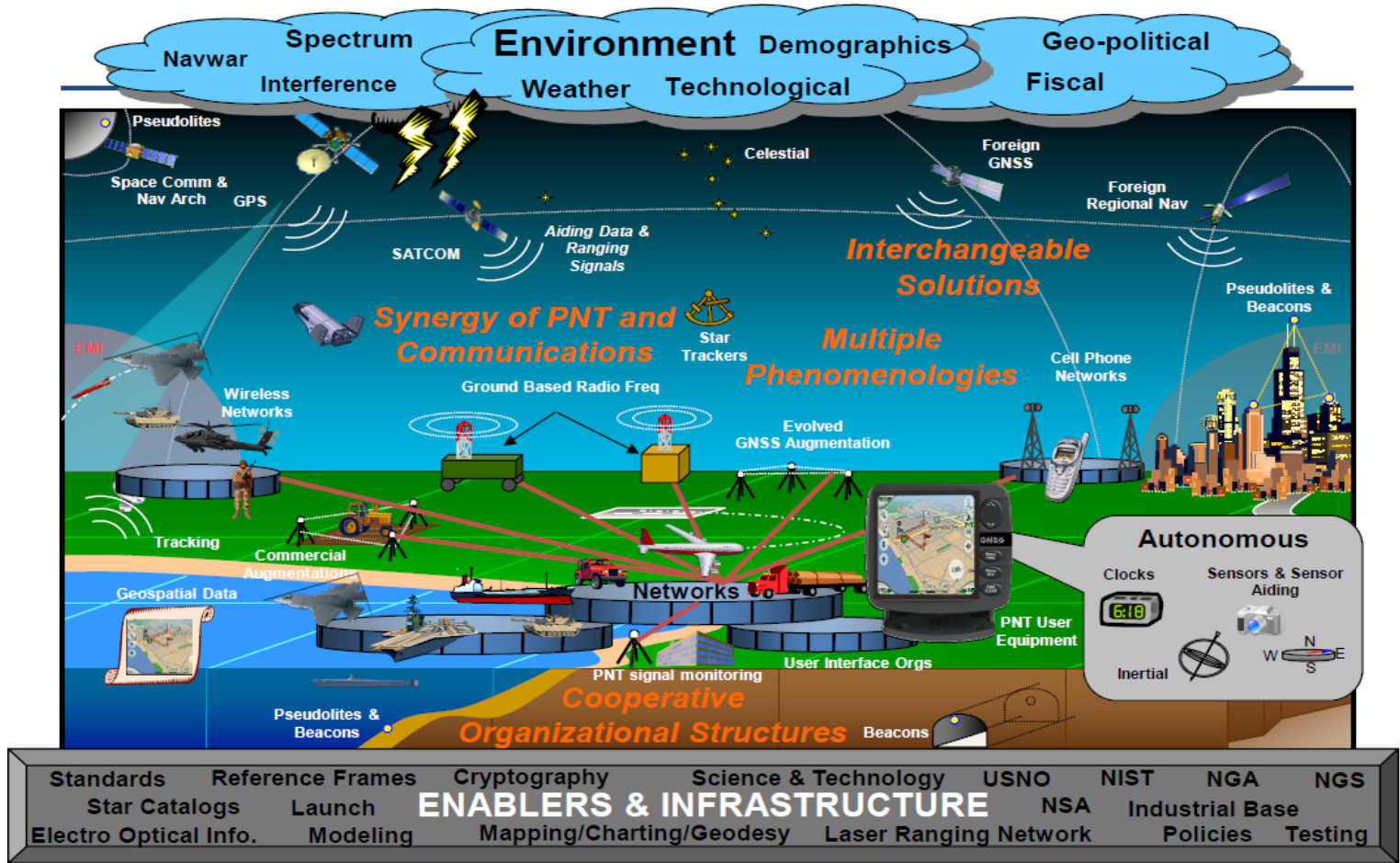
<https://navisp.esa.int>



**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