Achieving and derisking innovation in ESA Technology Programmes

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September 2013

Contents

ESA FACTS AND FIGURES

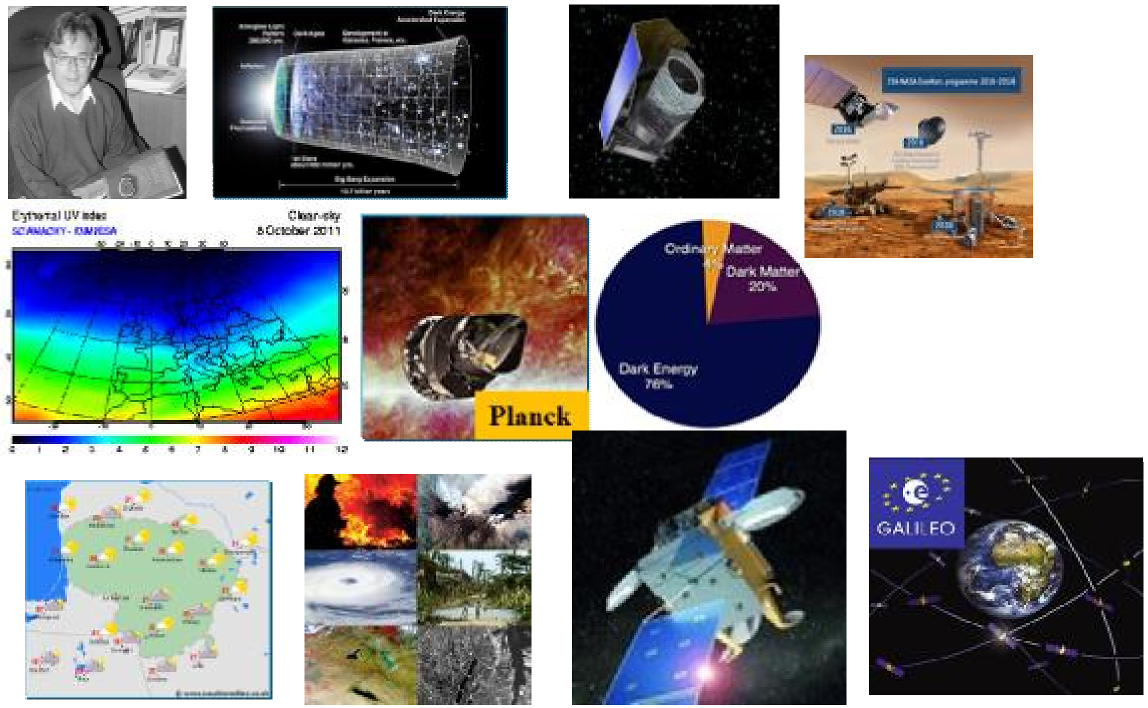
- Over 40 years of experience
- 20 Member States
- Eight sites in Europe,
  about 2200 staff
- 4 billion Euro budget (2012)
- Over 70 satellites designed, tested and operated in flight
- 17 scientific satellites in operation
- Six types of launcher developed
- More than 200 launches of Ariane

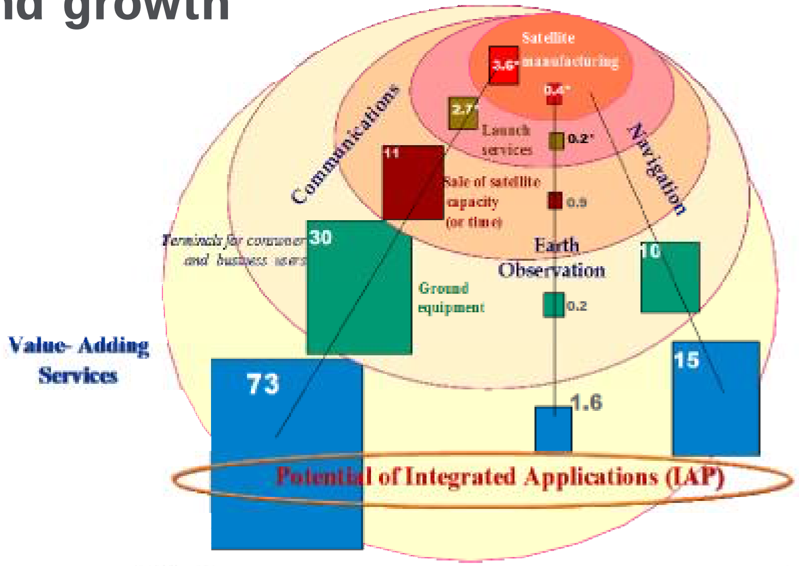
Introduction

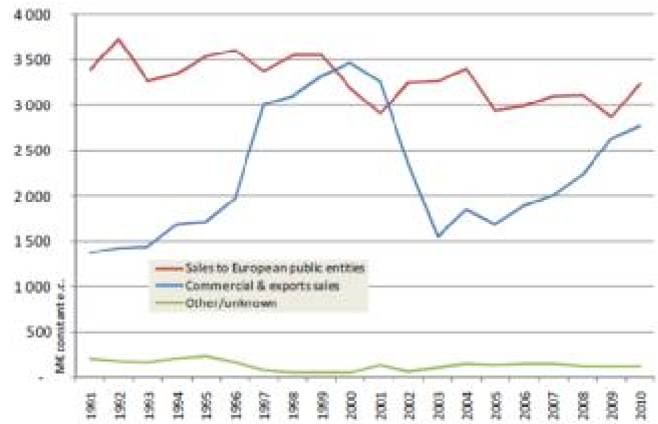
Cooperation Agreement	European Cooperating States	Member States in Transition	Member States
• Cyprus (2009) • Slovakia (2010) • **Lithuania (2010)** • Malta (2012) **Discussions With Bulgaria**	• Czech Republic (completed) • Hungary (from 2004 to 2013) • Romania (completed) • Poland (completed) • Estonia (2007), • Slovenia (2008) • Latvia (2013) • ***Lithuania expected***	• Portugal (completed) • Greece (completed) • Luxembourg (completed) • Czech Republic (from 2009 to 2014) • Romania (from 2011 to 2016) • Poland (from 2012) • **Hungary (negotiation)**	• Germany • Austria • Belgium • Denmark • Spain • Finland • France • **Greece** • Ireland • **Luxembourg** • Italy • Norway • Netherlands • **Poland** • **Portugal** • **Romania** • **Czech Republic** • United Kingdom • Sweden • Switzerland **+ Canada, associated State**

1. Introduction

- **In a few decades Space has become indispensable for research and services and it is part of daily life, source of wealth and growth**







Space pays off. ESA delivers.
ESA programmes: Industrial return 1, overall return >> 1

2. ESA objectives

Three inter-related strategic objectives:

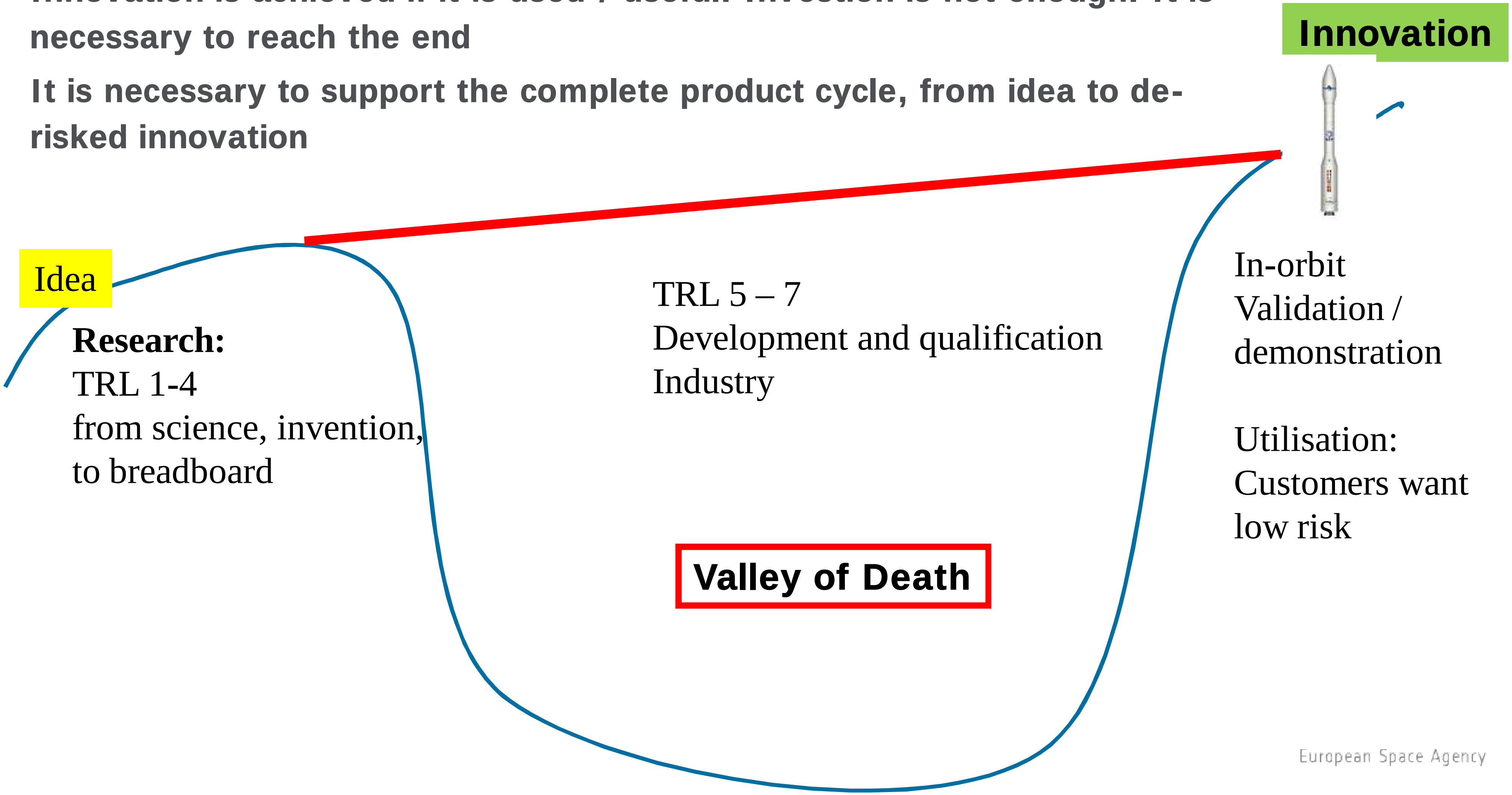
- **Pushing the frontiers of knowledge,**
  - **top class science of Space, in Space and from Space, including Nobel Prize winning Science, Science with high potential for applications**
- **Enabling services,**
  - **of high strategic and economic value, part of daily life: operational meteorology, remote sensing, telecommunications, navigation, space situation awareness , and more, individually each area and in concert, integrated applications**
- **Supporting an innovative and competitive Europe,**
  - **Most competitive industry in the world, > 1/3 of satellite communications market, 1/2 commercial launcher market, large fraction EO commercial market**
  - **Every € invested results in many downstream, high spin-off and GVA,**
  - **Also service prototyping (IAP), technology transfer and business incubation**
- **This has been possible by sustaining innovation**
- ***ESA technology programmes achieve and derisk innovation for Space and make of Space the innovative ingredient in many terrestrial products***

3. The basis: (sustaining) Innovation and Technology

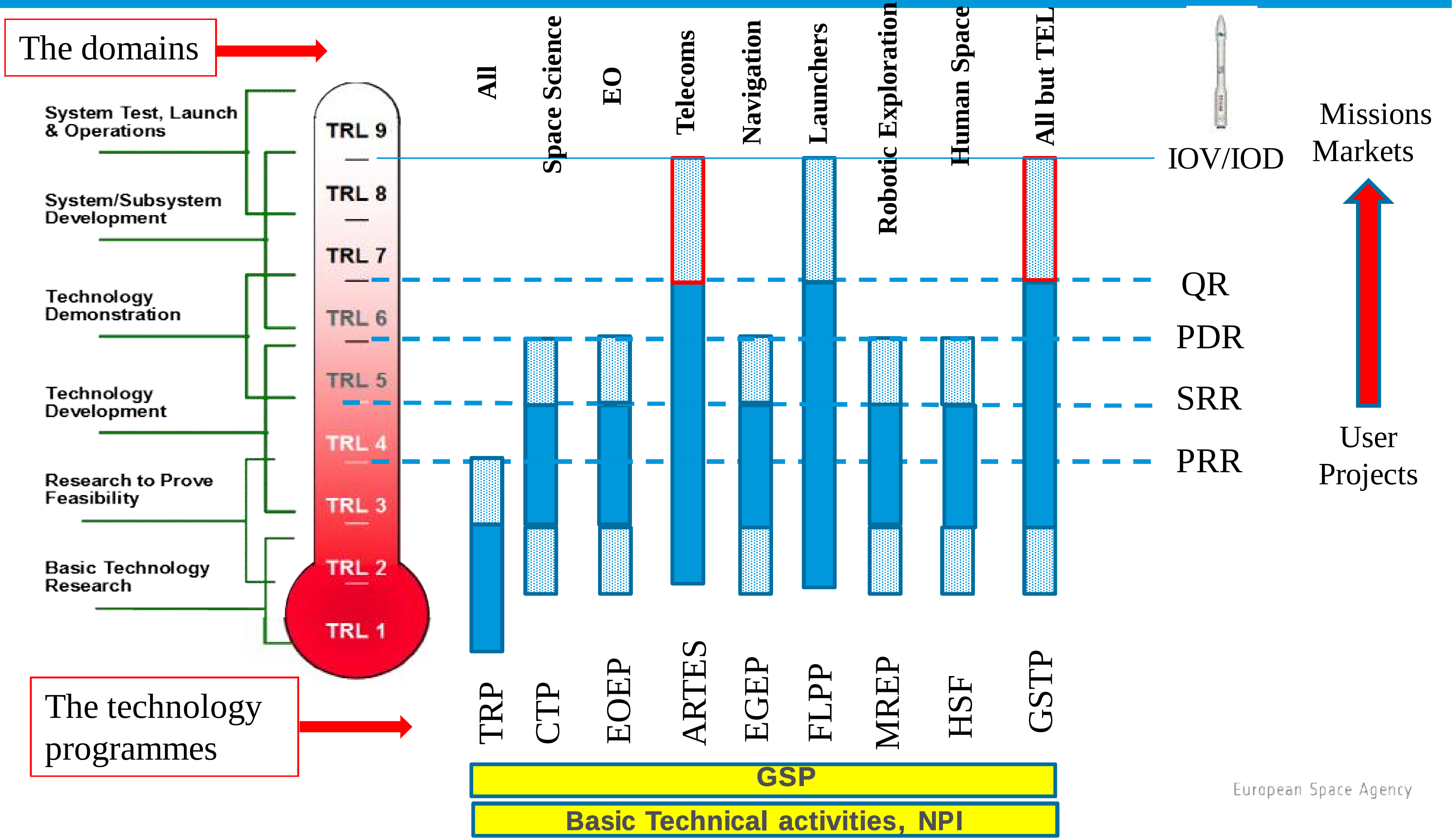
- **The answer is sustaining innovation**
- **Innovation is new stuff useful. Innovation is needed in**
  - **Mission concepts, new techniques: research, services, operations**
  - **System concepts, e.g. distributed instruments, SoS**
  - **Technology and products, problem driven and technology push**
  - **Processes, e.g. concurrent engineering, MBSE,**
  - **And in business and market models**
- **All enabled by technology**
- **Requiring a robust supply chain with non-dependent access to technologies and capabilities**
- **Implemented with the world's most competitive Space industry created in decades of R&T and industrial policy of ESA with Member States**

4. From invention to innovation: the complete cycle

- **Innovation is achieved if it is used / useful. Investion is not enough. It is necessary to reach the end**
- **It is necessary to support the complete product cycle, from idea to de-risked innovation**



4. From invention to innovation: ESA Technology Programmes



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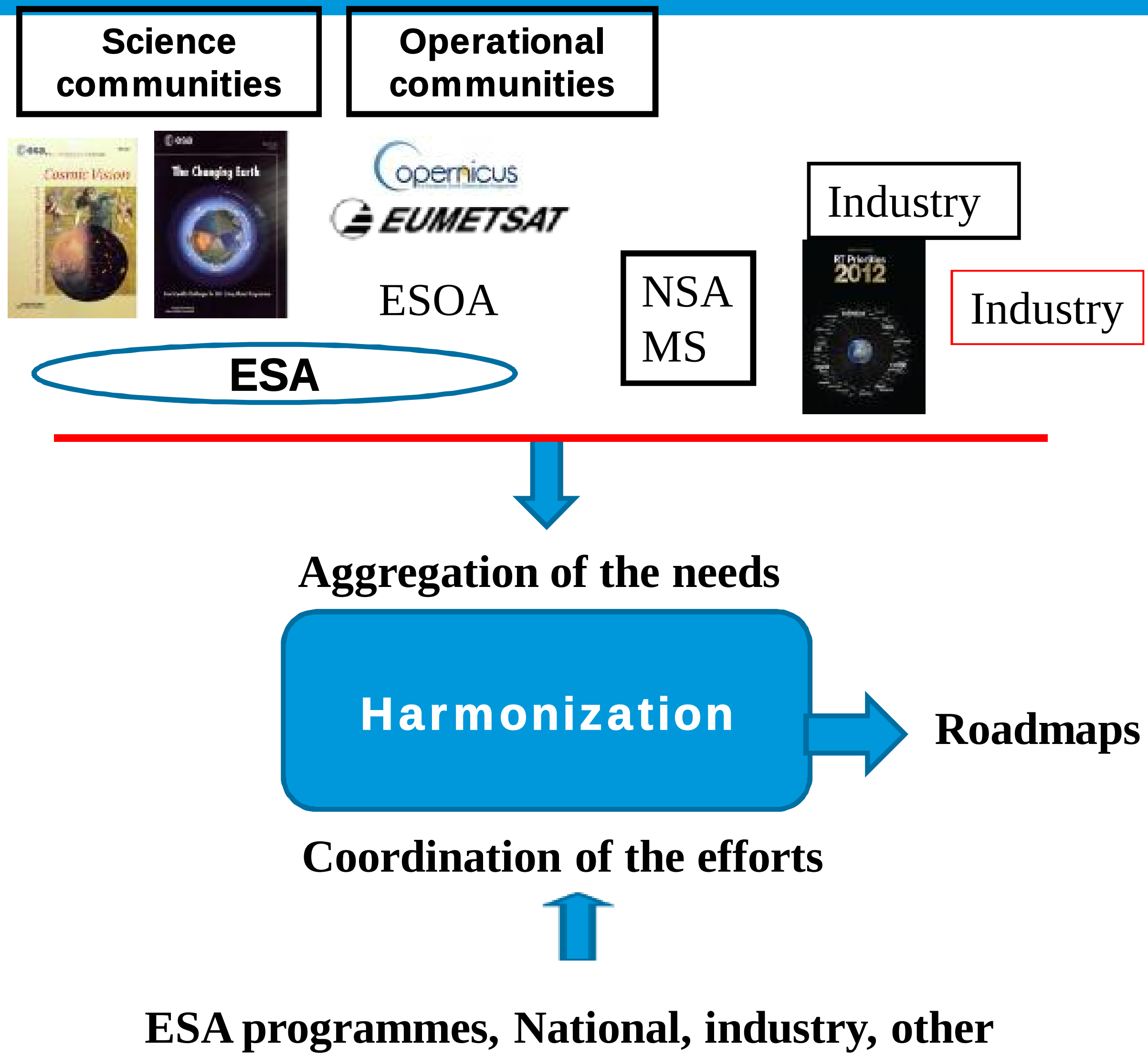
4. From invention to innovation: ESA Technology Programmes

- **Mandatory and optional**
- **Balance mission / market drive vs frontier research**
  - **Mission drive, E2E process with users, scientists, engineers,**
  - **Market drive, industry needs, permanently open AO: ARTES, GSTP**
  - **Frontier research, totally open and problem driven**
- **Balance generic versus domain specific, e.g. EO, Science, Telecom, etc**
- **Addressing all segments, space, ground, user**
- **Clear user specifications and roadmaps when top-down**
- **Funding mechanisms according to actor (academia, SME, large company) and proximity to market**
- **Open innovation, spin-in, off and joint R&D with other sectors**
- **ESA Technology Programmes provide the basis to achieve the objectives of Space: enabling missions, supporting industry and Member States aspirations**
- **Special mechanisms for Cooperating States and New Member States to facilitate integration in all frames: with European partners, in world projects, industrial, scientists, users, users and industry, etc.**

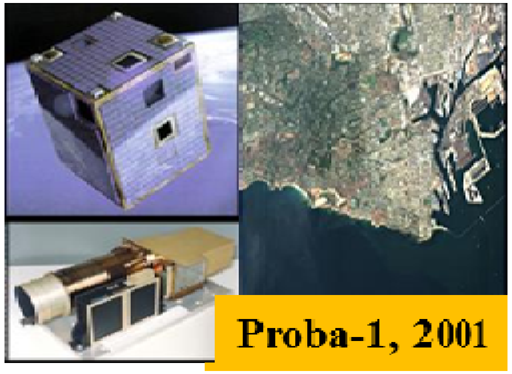
4. From invention to innovation: European coordination and harmonization

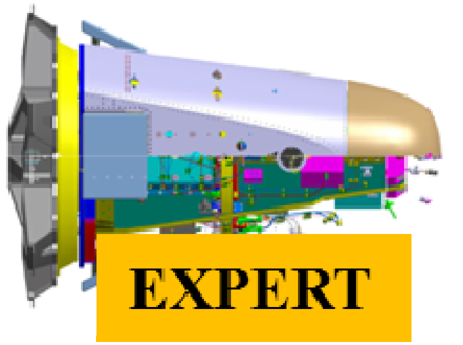


- Efficient European wide processes involving all stakeholders:
  - Aggregate their needs
  - Coordinate their efforts
- Supported by standardisation actions:
  - Reference architectures, agreed interfaces and building blocks specification
  - Engineering, quality and management standards

5. De-risk innovation: IOD/IOV

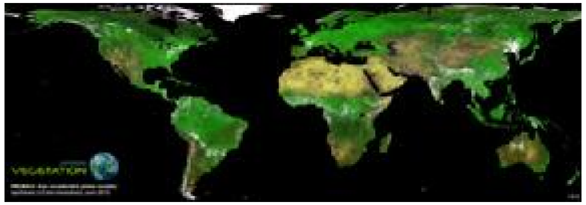
- **Inhibitor for innovation is user aversion of risk**
- **Innovation must be derisked through verification / validation / demonstration**
- **Achieved through ground verification / demonstration and when flight heritage is needed: in-orbit validation / demonstration (IOV/IOD)**
- **IOV/IOD supports infusion of innovation in:**
  - **Mission techniques**
  - **Architectures and system concepts**
  - **Technology and products**
  - **Development and operation approaches**



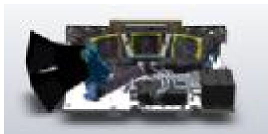


5. De-risk innovation: IOD/IOV

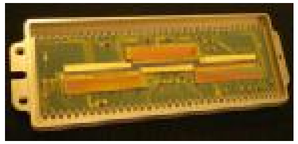
- **ESA programmes are usually first of its kind.**
- **ESA technology programmes support ground verification and demonstration and IOV/IOD outside user programmes**
- **This is mainly GSTP in general, ARTES telecommunication**
- **IOV/IOD is implemented as:**
  - **experiments in carriers of opportunity (TFO), GSTP 6 Element 3, ARTES ATLAS**
  - **on small dedicated spacecraft, GSTP, e.g. "Proba" series**
- **IOV / IOD also introduces newcomers, e.g. in new member states, or just to new markets**



First Proba-V composite, VITO

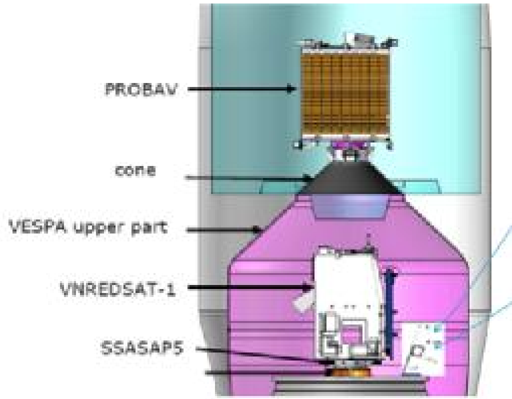


, Telescopes, AMOS



SWIR, XENICS

Proba-V, QS-BE



Example: Proba-V

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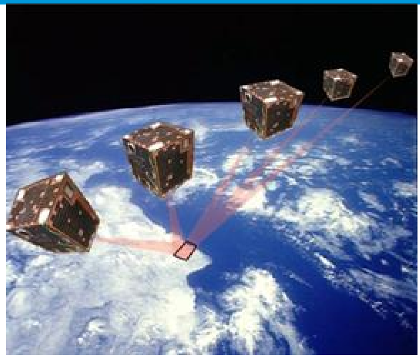
5. De-risk innovation: IOD/IOV: mission / operation techniques

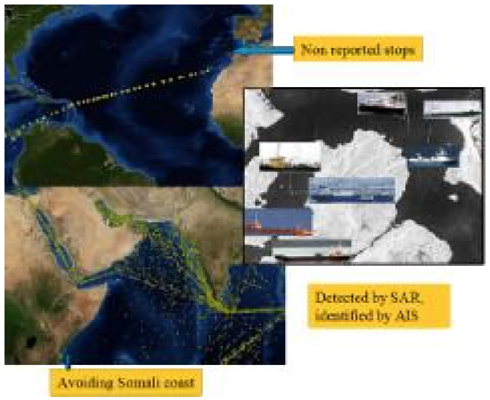
- **Every mission is based on a technique, for research, for services**
- **Some mission need new system concepts that may require special operation techniques, e.g. agility, RV, formation flying**



Proba-1, *Verhaert (BE)*
Multi-angular, hyperspectral observations used for a variety of research and applications
Autonomy and agility

Proba-V carries first space based ADSB receiver to monitor air traffic from space

Proba-3
Precise satellite formation flying



A Space AIS receiver operates since years from the ISS

5. De-risk innovation: IOD/IOV: technology and products

- **Lack of technical / technology maturity is the most influential cause of cost overruns in space projects**
- **A new item has higher cost and risk than an existing product**
- **Projects, commercial operators prefer demonstrated products**
- **Newcomers need to back their proposals with proven flight experience**
- **ESA technology programmes support flight demonstration / validation on carriers of opportunity and in ESA IOD missions such as Proba**

Proba-2 (Verhaert –BE) is operating since 2009 17 platform and payload experiments, affecting all systems
First Space Weather dedicated satellite, Space Weather Centre, Brussels

Example: AOCS class magnetometer
First Portuguese product
Demonstrated Proba-2, operational in 7 missions

Proba-V, (QS, OIP, BE) operational mission with IOD: TMA Al telescope, SWIR detectors, first GaN, fiber optics, S- X band systems

5. De-risk innovation: IOD/IOV: DDV and Ops approaches

- **An IOD mission must cost a fraction of the cost of the target missions.**
- **This implies <u>new cost efficient approaches</u> to design, development, verification and operations: e.g. Concurrent Engineering, Model Based Systems Engineering, Systems- SW co-engineering, HW-SW co-design, autocode,time-space partioning, synergies, functional benches – EGSE – Mission Control, navigation based operations, autonomy, etc.**
- **The new approaches are also subject of the IOD and are afterwards infused in mainstream projects**


Concurrent Design


Startiger: Rapid prototyping

5. De-risk innovation: Next IOD/IOV, Proba-3

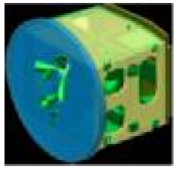
- **Proba-3, to be launched 2017 is the next mission in the Proba series devoted to IOD of innovation.**
- **It will de-risk innovation in all domains:**
  - **In techniques, precise formation flying, coronagraphy, autonomy and RV, proxops, CAM, convoy flight**
  - **In system concepts: distributed instruments, fractionated spacecraft**
  - **In technology and products, e.g. new metrology sensors, coarse and fine, new GPS receivers operating from LEO to beyond GEO, etc. with new components**
  - **In development and verification approaches, e.g. full autocode, new SW tool chain, etc.**
- **The core of the mission: precise formation flying**

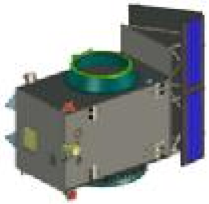
The Proba-3 industrial team will also include companies from several new member states: IOD role in providing flight heritage to newcomers

5. De-risk innovation: Next IOD/IOV, Proba-3

- **To observe smaller features and weaker signals, we need larger apertures, longer baselines**
- **They hat can not be achieved by single satellites or deployable structures.**
- **The <u>solution</u>: distributed instruments and fractionated spacecraft**
- **The <u>underlying technique</u>: precise satellite formation flying (PFF).**
- **Proba-3 will be the world's first PFF mission.**
- **Two small (Proba) but high performance satellites will behave as a single entity at distances between 25 – 250 m with mm and arcsec relative precision**
- **It will form the largest ever sun coronagraph, 250 m baseline, observing the sun corona down to the limb like never before**
- ***Proba-3 has the potential to change the way we do missions. It opens a new way to mission architecting***

Occulter satellite

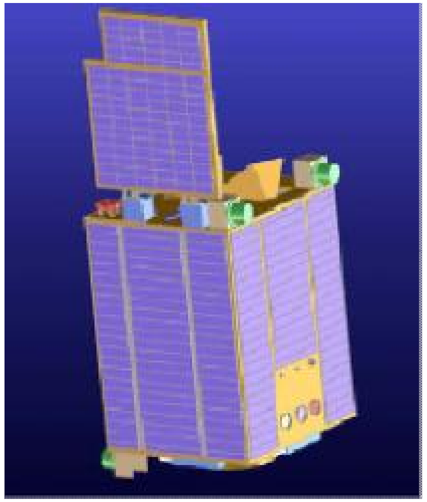




Coronagraph satellite

5. De-risk innovation: the future

- IOD/IOV is a demand of industry so as to derisk innovation and obtain flight heritage
- ESA technology programmes, specially ARTES (telecommunications) and GSTP (all) support IOD/IOV
- GSTP supports IOD through
    - Dedicated small satellites, cubesats
    - Technology flight opportunities
- Several concept studies are on-going for the next IOD missions of the Proba series
- With inputs from the stakeholders, open data bases are being built of experiment needs and of flight opportunities
- ESA will broker agreements, and in GSTP conduct accommodation studies prior to experiment development and flight



ALTIUS, a potential new IOD

GNSS reflectometry

6. Conclusions

- **Space has become indispensable for research and applications. It is part of daily life.**
- **For Space to remain essential, it is necessary to sustain innovation**
- **Technology is enabling it all**
- **ESA technology programmes support the complete development cycle from invention to innovation**
- **ESA technology programmes offer a balance between top down and frontier research, specific and generic and offer suitable mechanisms for interaction with Member States, users and developers**
- **Main inhibitor to innovation is risk that alienates users. IOV / IOD is fundamental for de-risking of innovation and is supported by ESA technology programmes**
- **IOD is also important for newcomers to be accepted in main stream business**
- **ESA Technology Programmes support achieving and de-risking innovation**