



# THE EUROPEAN SPACE AGENCY

January 2017

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# Space Information Day: Agenda



- ESA: Facts and Figures
- ESA Organization and Functioning
- The ESA Convention
- Geo-Return Principle
- ESA: Mandatory and Optional Programmes
- ESA and the European Union
- Standardization and ECSS





# ESA CONVENTION

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# Purpose of ESA



“CONSIDERING that the magnitude of the human, technical and financial resources required for activities in the space field is such that these resources lie **beyond the means of any single European Country**

Preamble of ESA Convention



“To provide for and promote, for exclusively peaceful purposes, **cooperation** among European states in **space research** and **technology** and their **space applications.**”

Article 2 of ESA Convention



# Member States



**ESA has 22 Member States: 20 states of the EU (AT, BE, CZ, DE, DK, EE, ES, FI, FR, IT, GR, HU, IE, LU, NL, PT, PL, RO, SE, UK) plus Norway and Switzerland.**

Seven other EU states have Cooperation Agreements with ESA: Bulgaria, Cyprus, Latvia, Lithuania, Malta and Slovakia. Discussions are ongoing with Croatia.

Canada is Associated State and takes part in some programmes under a long-standing Cooperation Agreement.

Slovenia is the latest country to sign an Association Agreement with ESA.



# Birth of commercial operators



## ESA's 'catalyst' role

ESA is responsible for R&D of space projects. On completion of qualification, they are handed to outside entities for production and exploitation. Most of these entities emanated from ESA.

- Meteorology: Eumetsat
- Launch services: Arianespace
- Telecomms: Eutelsat and Inmarsat



# ESA and the European space sector



ESA Member States finance 50% of the total public space spending in Europe. Because of the cooperation between ESA, EC and the national space agencies:

- the European space industry sustains around 35 000 jobs;
- Europe is successful in the commercial arena, with a market share of telecom and launch services higher than the fraction of Europe's public spending worldwide;
- European scientific communities are world-class and attract international cooperation;
- research and innovation centres are recognised worldwide;
- European space operators (Arianespace, Eumetsat, Eutelsat, SES Global, etc.) are the most successful in the world.





# ESA GEO-RETURN PRINCIPLE

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# Geo-Return Principle



ESA commits with each of its Member States to return the corresponding contribution in the form of industrial contracts at the end of each subscription period.

ESA programmes are multiannual as they are the country commitments. This means that companies involved in ESA projects have a guarantee that the budget will not be cancelled before the end of the subscription period.

Commitments on budget side, as presented here, are accounted in totality at the moment of contract signature, not when payments are made as consequence the annual variations in budget expenditure are expected to be larger than the accrued industrial turnover that would be closer to the averages presented here.

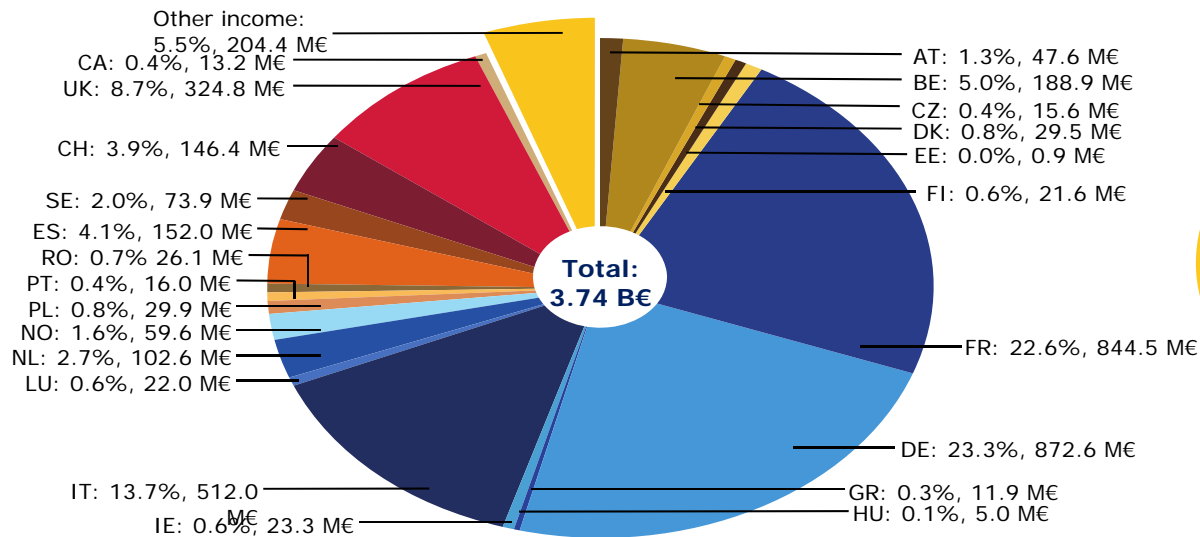
The industrial activity is shifted respective to country contribution; the country contribution starts and ends earlier than the industrial activity and payments to industry.



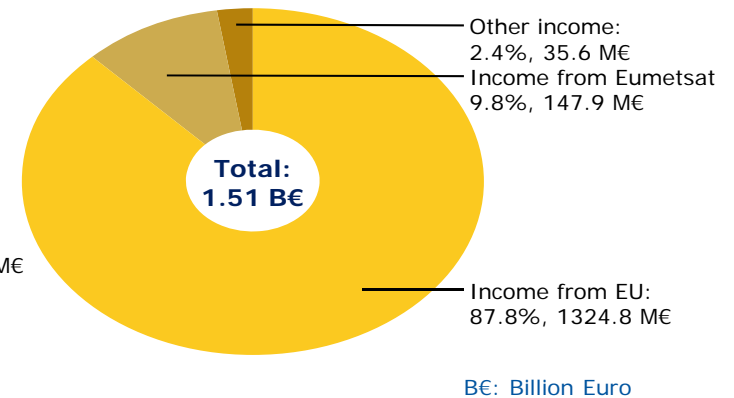
# ESA budget for 2016



## ESA Activities and Programmes



## Programmes implemented for other Institutional Partners



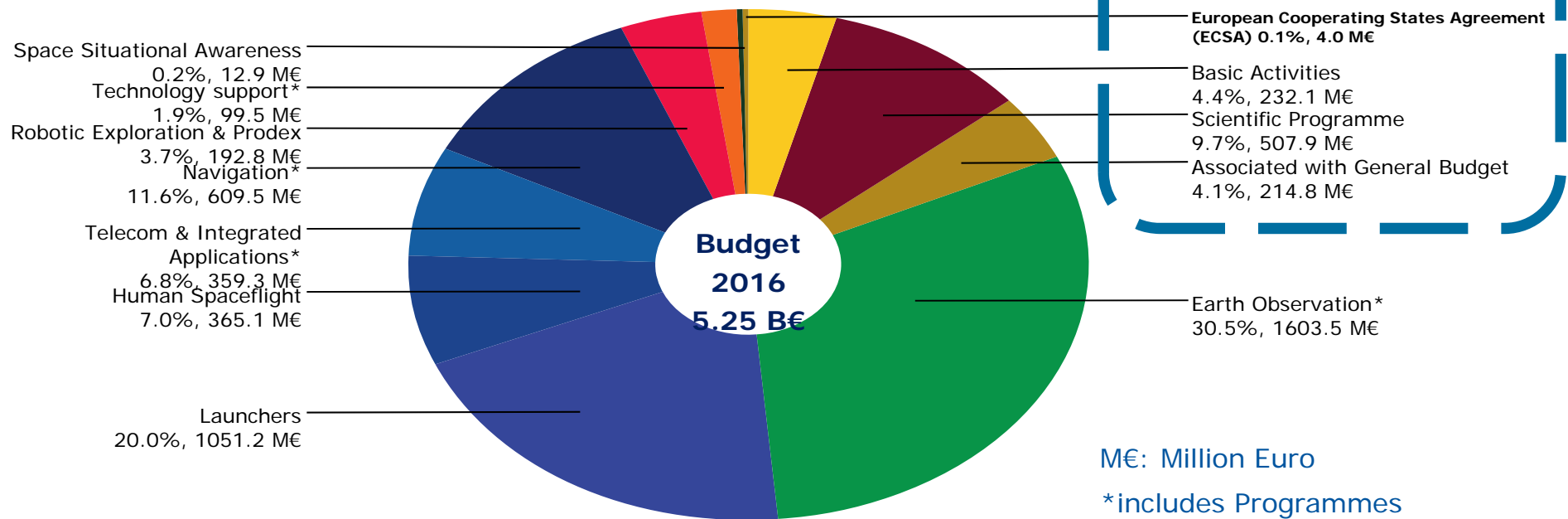
B€: Billion Euro

Total ESA budget for 2016: 5.25 B€

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# ESA 2016 budget by domain

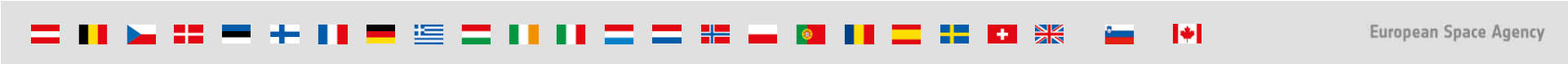
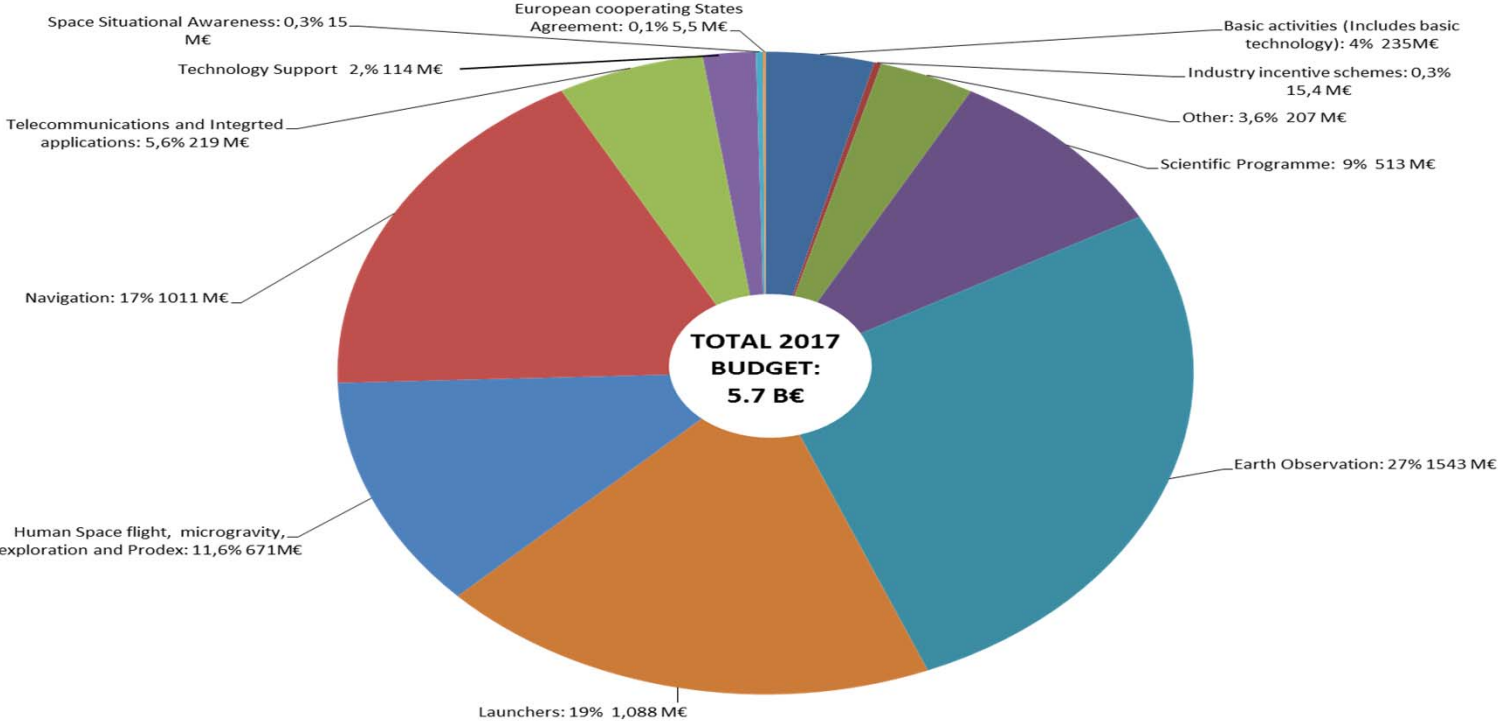


M€: Million Euro

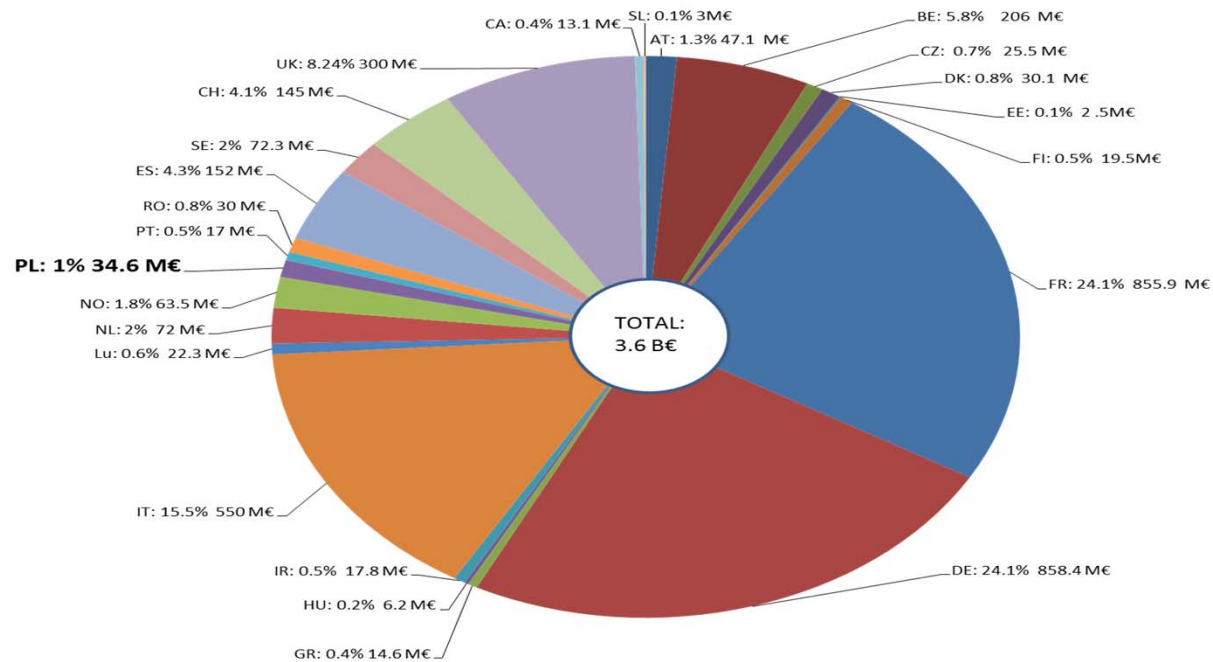
\*includes Programmes implemented for other Institutional Partners



# ESA Budget (2017) per Activity Domain



# ESA budget for 2017 Allocation per Member State



**Total ESA budget for 2017: 5.7 B€**



# ESA's industrial policy



About 85% of ESA's budget is spent on contracts with European industry.

## ESA's industrial policy:

- ensures that Member States get a fair return on their investment;
- improves competitiveness of European industry;
- maintains and develops space technology;
- exploits the advantages of free competitive bidding, except where incompatible with objectives of the industrial policy.



## Contribution and Industrial return



The industrial business generated by ESA in ESA programmes equals the country and third parties contributions minus ESA functioning cost.

Most of the functioning cost is included as general expenses in the general budget (maintenance of facilities, ...) in addition each programme has its own variable overheads to cover for costs incurred in the support to projects.

ESA commits in returning to each contributing country and in each contributed programme the amount contributed minus ESA overhead in the form of industrial contracts. The formal calculation of the return and if it is the case corresponding adjustments happens every 5 years.

Activities implemented on behalf of other institutional partners may not be object of formal geographical return requirement, but experience shows that the allocation of contracts in third activities on behalf of other partners follow the map of space competences in Europe that is very close to the map of contributions to ESA.





# ESA FACTS AND FIGURES

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# ESA facts and figures



- Over 50 years of experience
- 22 Member States
- Eight sites/facilities in Europe, about 2200 staff
- 5.2 billion Euro budget (2016)
- Over 80 satellites designed, tested and operated in flight



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# ESA's locations



- ESA sites
- Offices
- ESA Ground Station
- ESA Ground Station + Offices
- ESA sites + ESA Ground Station

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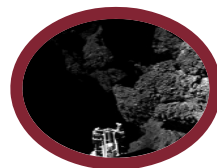
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# Activities



ESA is one of the few space agencies in the world to combine responsibility in nearly all areas of space activity.

\* Space science is a Mandatory programme, all Member States contribute to it according to GNP. All other programmes are Optional, funded 'a la carte' by Participating States.



space science



human spaceflight



exploration



earth observation



launchers



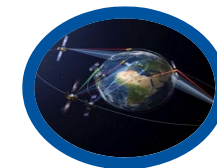
navigation



operations



technology



telecommunications

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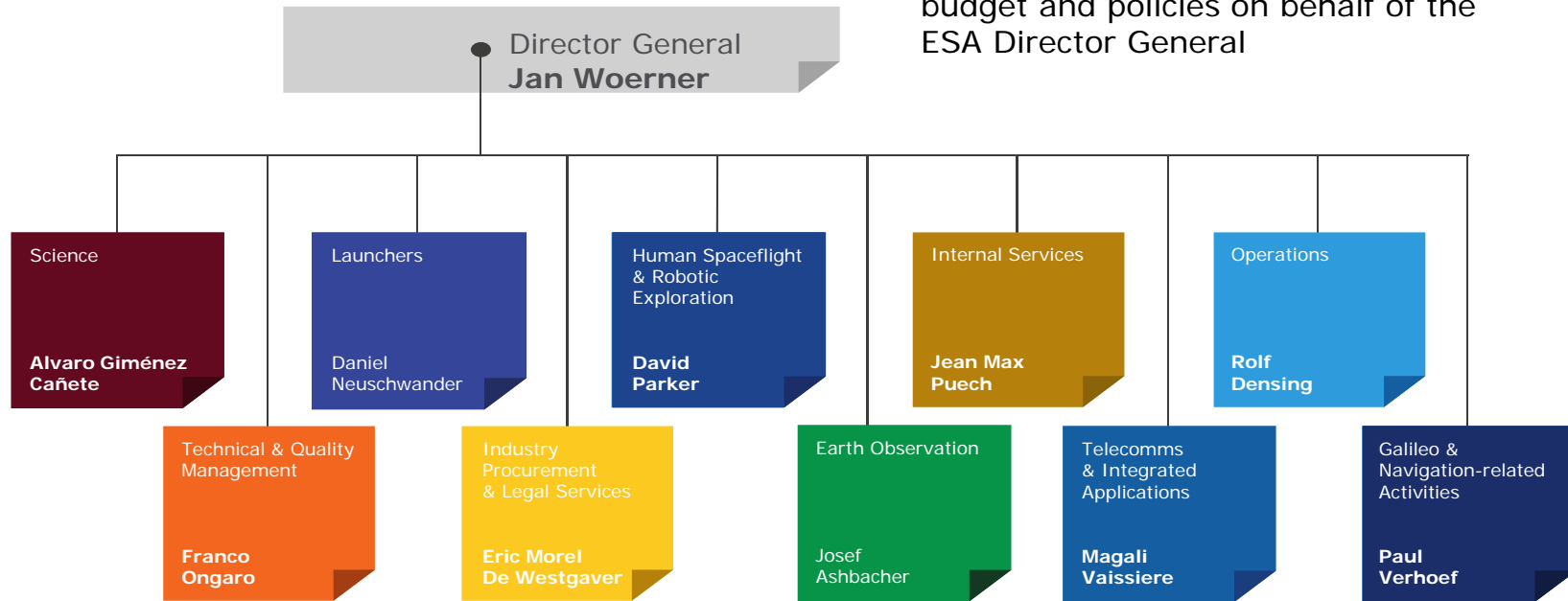


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# ESA directors



The ESA directors implement the ESA budget and policies on behalf of the ESA Director General





# ESA ORGANISATION AND FUNCTIONING

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# ESA Council



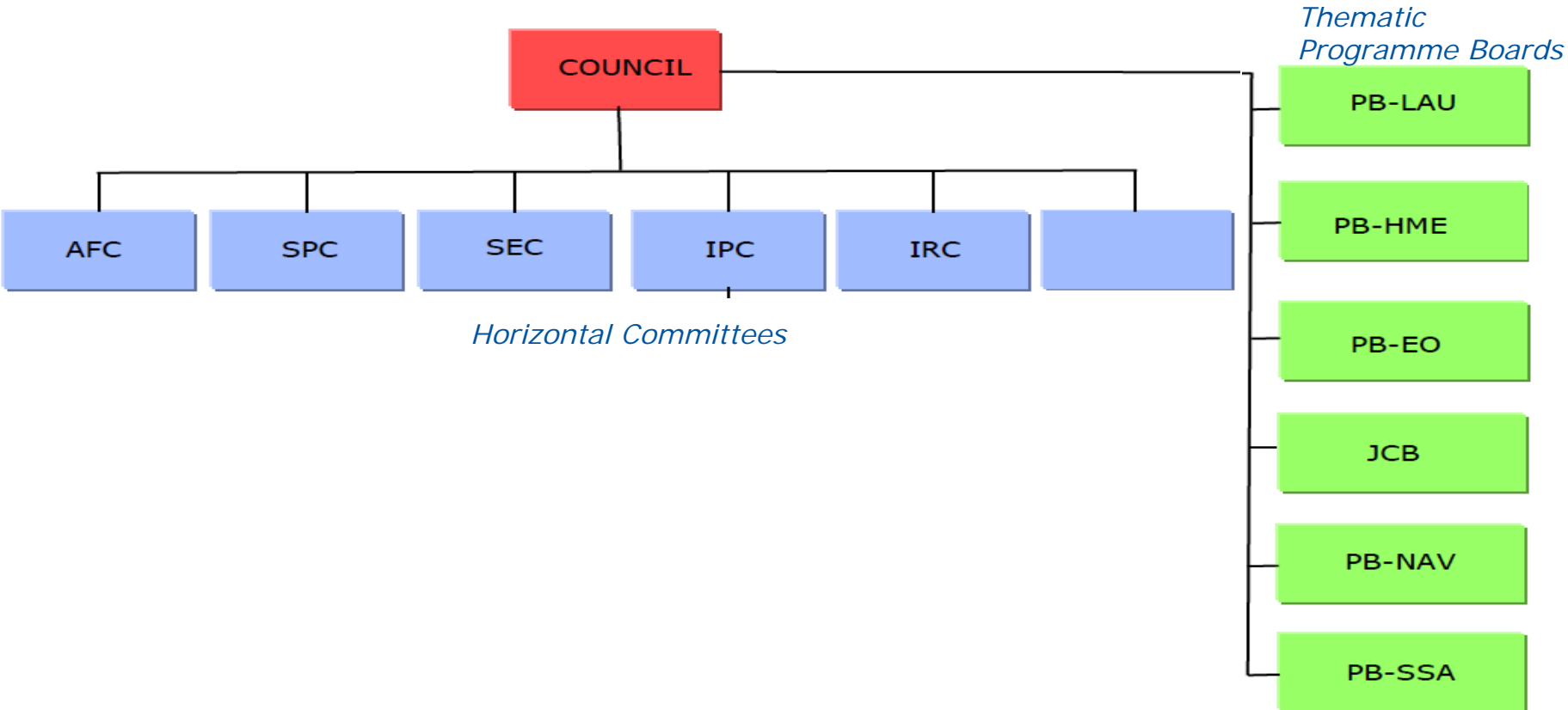
The Council is the governing body of ESA. ESA General Director reports to the Council

The Council provides the basic policy guidelines for ESA's activities. Each Member State is represented on the Council and has one vote.

Every two to three years, Council meets at ministerial level (**'Ministerial Council'**) to take key decisions on new and continuing programmes and financial commitment.



# Organigram of ESA Delegate Bodies



# ESA Subordinate Bodies



- **AFC,** dealing with financial matters
- **IRC,** dealing with international relations issues
- **IPC,** check-writing board dealing with technology and industrial policy
- **SPC,** dealing with issues related to the ESA Science programme
- **PB-LAU,** dealing with issues related to the launcher programmes
- **PB-HME,** dealing with issues related to the human and robotic exploration programmes.
- **JBC,** dealing with issues related to the telecommunication and integrated applications programme.
- **PB-NAV,** dealing with issues related to the navigation programme
- **PB-EO,** dealing with issues related to Earth Observation programme
- **PB-SSA,** dealing with issues related to Space Situational Awareness programme





## Ministerial Council 2014, Luxembourg



Ministers agreed on further development of a family of new launchers, and approved funding for the International Space Station and space exploration. Ministers also set a course for ESA to remain an independent, world-class intergovernmental space organisation. The next Council at ministerial level is scheduled for the beginning of December 2016 in Lucerne, Switzerland.

Three Resolutions were adopted:

- **Resolution on Europe's access to space**, covering Ariane 6 and Vega C;
- **Resolution on Europe's space exploration strategy**, covering Low-Earth Orbit, Moon and Mars;
- **Resolution on ESA evolution**, covering the vision for ESA until 2030.





# ESA MANDATORY AND OPTIONAL PROGRAMMES

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# ESA PROGRAMMES



## Mandatory Programmes\*

- Science Core Technology Programme (CTP),
- Basic Technology Research Programme (TRP)
- General Study Programme (GSP)

## Optional Programmes\*

- General Support Technology Programme (GSTP)
- Earth Observation Envelope Programme (EOEP)
- Advanced Research in Telecommunication Systems (ARTES)
- European GNSS Evolution Programme (EGEP)
- Future Launchers Preparatory Programme (FLPP)
- Transportation and Human Exploration Preparation (THEP)
- Robotic Exploration (ETP)

Note (\*): Prior Ministerial Council in Lucerne (Dec, 2016)





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# Mandatory Programmes



All Member States contribute according to their GNP level.

Preparation, development, launch, operations and support to exploitation of missions:

- L class (about 1.000 M€),
- M class (about 550 M€),
- S and opportunity (about 50 M€),

The European Science community proposes, evaluates, recommends for selection, defines and exploits Science missions.

Payloads are usually provided by Member States, financed by national plans or by contribution to the ESA optional programme PRODEX.

The satellite development activities are organised following a phased approach and awarded in open competition.

Mission contracts are awarded to prime contractors that shall select an industrial team of subcontractors considering geographical return targets.

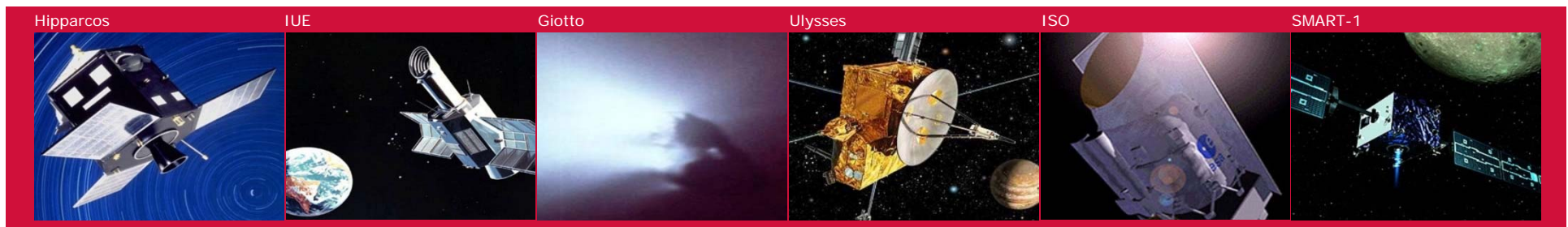
Ground operations (data processing, mission control, infrastructure maintenance



## ESA's pioneers of space science (1)



- **Hipparcos** (1989–93) first comprehensive star-mapper
- **IUE** (1978–96) longest-lived orbital ultraviolet observatory
- **Giotto** (1986) first close flyby of a comet nucleus
- **Ulysses** (1990–2008) first spacecraft to fly over Sun's poles
- **ISO** (1995–8) first European infrared observatory
- **SMART-1** (2003–6) first European mission to the Moon



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## ESA's pioneers of space science (2)



- **Planck** (2009–13) detecting first light of Universe and looking back to the dawn of time
- **Herschel** (2009–13) unlocking the secrets of starbirth and galaxy formation and evolution
- **Venus Express** (2005–15) first global investigation of dynamic atmosphere of Venus



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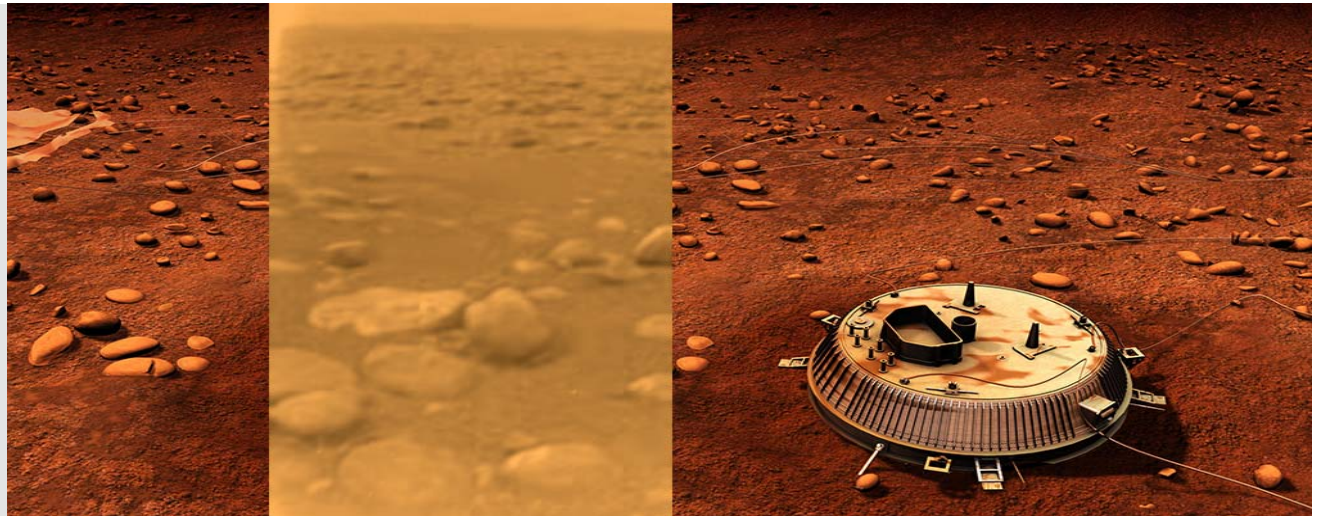


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## First landing on a world in the outer Solar System

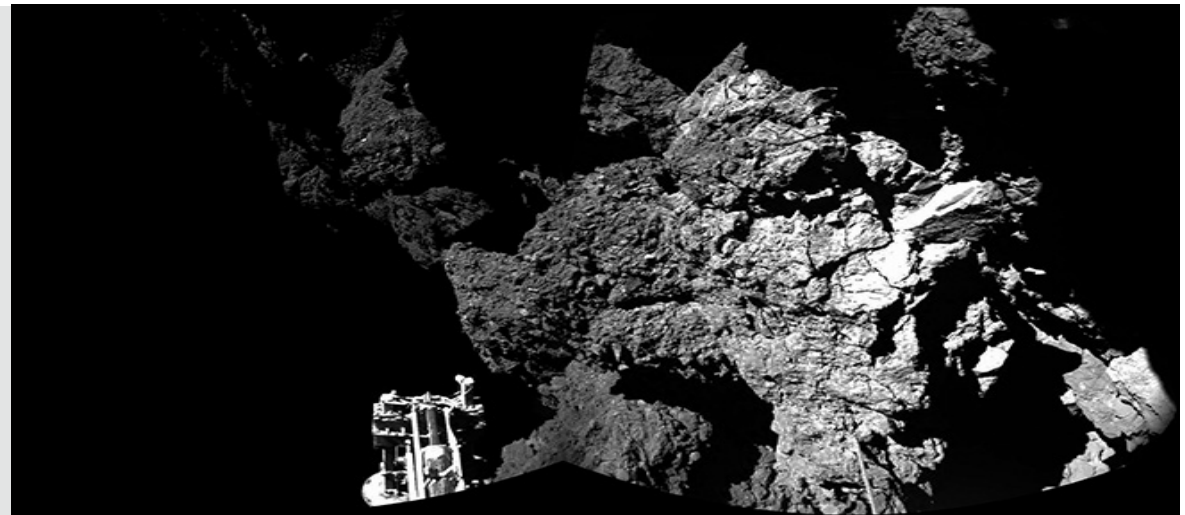
On 14 January 2005, ESA's **Huygens** probe made the most distant landing ever, on Titan, the largest moon of Saturn (about 1427 million km from the Sun).





## First rendezvous, orbit and soft-landing on a comet.

On 6 August 2014, ESA's **Rosetta** became the first spacecraft to rendezvous with a comet and, on 12 November, its Philae probe made the first soft-landing on a comet and returned data from the surface.



## 🚀 Today's Science missions (1)



- **Hubble** (1990– ) orbiting observatory for ultraviolet, visible and infrared astronomy (with NASA)
- **SOHO** (1995– ) studying our Sun and its environment (with NASA)
- **XMM-Newton** (1999– ) solving mysteries of the X-ray Universe
- **Cluster** (2000– ) studying interaction between Sun and Earth's magnetosphere



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## Today's Science missions (2)



- **Mars Express** (2003– ) studying Mars, its moons and atmosphere from orbit
- **Rosetta** (2004– ) the first long-term mission to study and land on a comet
- **Gaia** (2013– ) mapping a thousand million stars in our galaxy
- **LISA Pathfinder** (2015– ) testing technologies to detect gravitational waves



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## Upcoming missions (1)



- **BepiColombo** (2017) a satellite duo exploring Mercury (with JAXA)
- **Cheops** (2018) studying exoplanets around nearby bright stars
- **Solar Orbiter** (2018) studying the Sun from close range
- **James Webb Space Telescope** (2018) studying the very distant Universe (with NASA/CSA)



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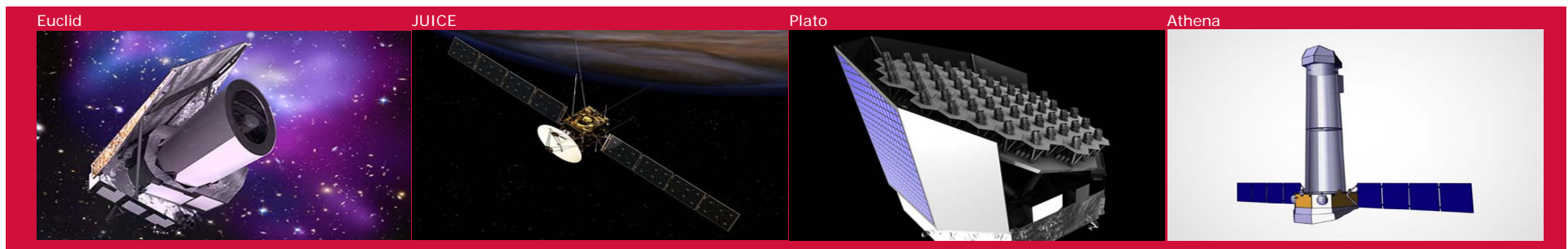


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## Upcoming missions (2)



- **Euclid** (2020) probing 'dark matter', 'dark energy' and the expanding Universe
- **JUICE** (2022) studying the ocean-bearing moons around Jupiter
- **Plato** (2024) searching for planets around nearby stars
- **Athena** (2028) space telescope for studying the energetic Universe
- **Gravitational wave observatory** (2034) studying ripples in spacetime caused by massive objects in the Universe



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## Science operations



**ESAC** (near Madrid, Spain) is ESA's centre for science operations.

ESAC hosts ESA's Science Operation Centre (SOC) for ESA astronomy and Solar System missions.

Science operations include the interface with scientific users, mission planning, payload operations and data acquisition, processing, distribution and archiving.

The scientific archives for the majority of ESA's science missions are kept here so that researchers have a single 'entry point' for accessing the wealth of scientific data.



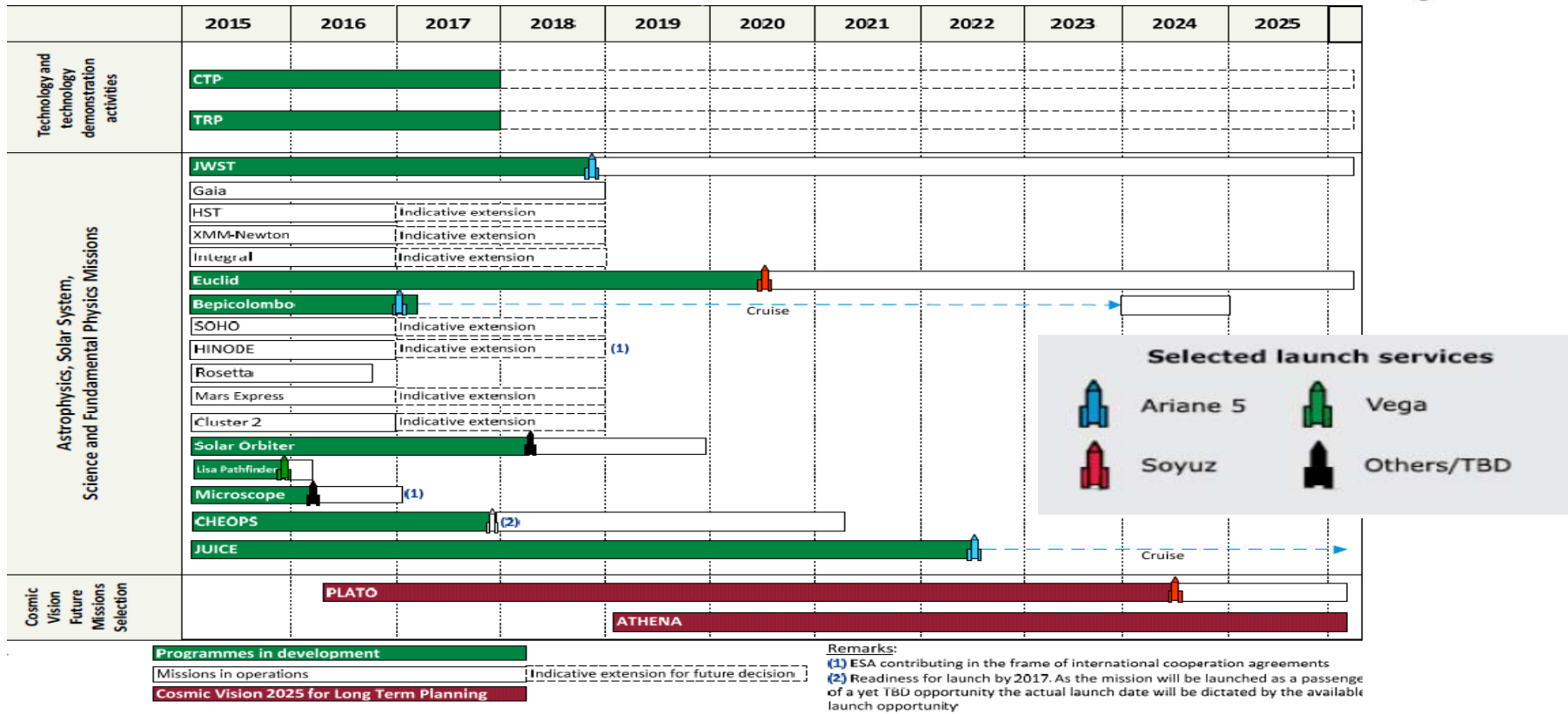
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# Science missions in development and operation



A green banner with a folded top-right corner. On the left is a circular icon of Earth with a satellite orbiting it. To the right of the icon, the words 'EARTH' and 'OBSERVATION' are written in large, white, bold, sans-serif capital letters, stacked vertically.

# EARTH OBSERVATION

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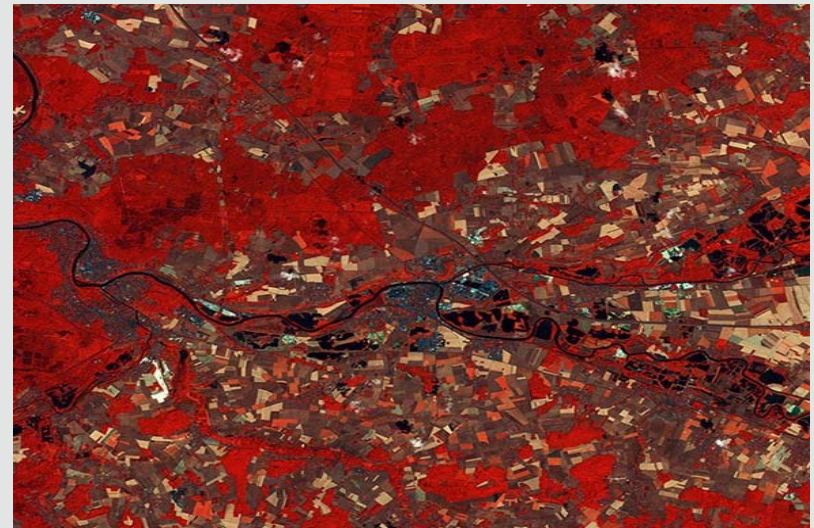
## Pioneers in Earth observation



ESA has been dedicated to observing Earth from space ever since the launch of its first meteorological mission, **Meteosat-1** in 1977.

**ERS-1** (1991–2000) and **ERS-2** (1995–2011) providing a wealth of invaluable data about Earth, its climate and changing environment.

**Envisat** (2002–12) the largest satellite ever built to monitor the environment, it provided continuous observation of Earth's surface, atmosphere, oceans and ice caps.



## ESA's eye on Earth



**ESRIN**, in Frascati, Italy, is ESA's centre for Earth Observation, where operations and exploitation of Earth Observation satellites are managed.

The world's largest database of environmental data for both Europe and Africa is managed from ESRIN.



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# Earth Explorers



These missions address critical and specific issues raised by the science community, while demonstrating the latest observing techniques.

- **GOCE** (2009–13 ) studying Earth's gravity field
- **SMOS** (2009– ) studying Earth's water cycle
- **CryoSat-2** (2010– ) studying Earth's ice cover
- **Swarm** (2013– ) three satellites studying Earth's magnetic field
- **ADM-Aeolus** (2016) studying global winds
- **EarthCARE** (2018) studying Earth's clouds, aerosols and radiation (ESA/JAXA)
- **Biomass** (2020) studying Earth's carbon cycle





## Meteorological missions



Next-generation missions dedicated to weather and climate.

**Meteosat Third Generation** – taking over from Meteosat 11 in 2018/20, the last of four Meteosat Second Generation (MSG) satellites. MSG and MTG are joint projects between ESA and Eumetsat.

**MetOp** is a series of three satellites to monitor climate and improve weather forecasting, the space segment of Eumetsat's Polar System (EPS).

**MetOp-A** (2006– ) Europe's first polar-orbiting satellite dedicated to operational meteorology.

**MetOp-B** launched in 2012.

**MetOp-C** follows in 2018.

# Global monitoring for a safer world



**Copernicus:** an Earth observation programme for global monitoring for environment and security.

Led by the European Commission in partnership with ESA and the European Environment Agency, and responding to Europe's need for geo-spatial information services, it will provide autonomous and independent access to information for policy-makers, particularly for environment and security issues. ESA is implementing the space component: developing the **Sentinel** satellite series, its ground segment and coordinating data access.

ESA has started a **Climate Change Initiative**, for storage, production and assessment of essential climate data.



# ESA Earth Observation Programmes



# Earth Observation



Yearly average budget about 1.500 M€; approximately 500 M€ from Member States contributions and 1.000M€ from other institutional partners programmes (Eumetsat 260M€ and EU 720M€).

The ESA Earth Observation Envelope Programme (EOEP) has an approximated average budget of 350M€ per year. All ESA member States except Hungary participate in the EOEP programme.

Research (formerly Earth Explorer) missions component, research oriented; proposed and selected by the science community. Comprises definition, development, launch and operation of missions (phases B,C,D,E)





# Earth Observation overview



EOEP	Earth Watch			
	GMECV	InCubed	Altius	
Initiated by ESA, Eumetsat, EU, science community	Global Climate Observing System (GCOS)	Initiated by industry	Initiated by ESA	Others on user's demand
Complete satellite missions, from definition to operations, including instruments development	Integrating calibrated data sets, developing models and algorithms	Competitiveness, covering R&D and pre-competitive activities	Limb sounder mission for monitoring of the 3D distribution and evolution of stratospheric ozone	
100% funded, Firm fixed	100% funded, Firm fixed	Cofounding (PPP, in kind contribution, ...)	100% funded, Firm fixed	
Rolling envelope programme, publication of ITTs in EMITS. Selection of Prime contractor and best practices for selection of subcontractors for satellite development	Rolling programme, publication of ITTs	Open call for proposals, Announcement of Partnership Opportunity (APO)	ITT published in EMITS. Selection of Prime contractor and best practices for the selection of subcontractors	
Open competition to economic operators of all participating states	Open competition to economic operators of all participating states	Letter of support from Delegation. Direct negotiation	Open competition to economic operators of all participating states	







An orange horizontal banner with a folded top-right corner. On the left, there is a circular icon containing three interlocking gears. To the right of the icon, the word 'TECHNOLOGY' is written in large, white, uppercase, sans-serif font.

# TECHNOLOGY

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## Space technology



The development of technology, along with access to space, is one of the enabling activities of ESA. ESA's technical heart is **ESTEC** (NL).

- Supporting competitiveness of European industry.
- Transferring technology from space to non-space applications ('spin-off'), and bringing innovations from outside the space sector to use in design of new space systems ('spin-in').
- Fostering innovation and enhancing European technological independence and the availability of European resources for critical technologies.
- Creating **Space Incubators** across Europe.



## ESA's technical heart



**ESTEC** is the incubator of the European space effort, where most ESA projects are born and where they are guided through the various phases of development.

This is home to the Directorate of Technical and Quality Management, responsible for longer-term technology development for new ESA and European missions.



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## Proba



Proba satellites are part of ESA's In-orbit Technology Demonstration Programme.

New technology products need to be demonstrated in orbit, particularly when users require evidence of flight heritage or when there is a high risk associated with the use of the new technology.

Proba satellites are among the smallest spacecraft ever to be flown by ESA, but they are making a big impact in the field of space technology.

**Proba-1** (2001– )

**Proba-2** (2009– )

**Proba-V** (2013– )

**Proba-3** (2018)



# ESA TECHNOLOGY PROGRAMMES

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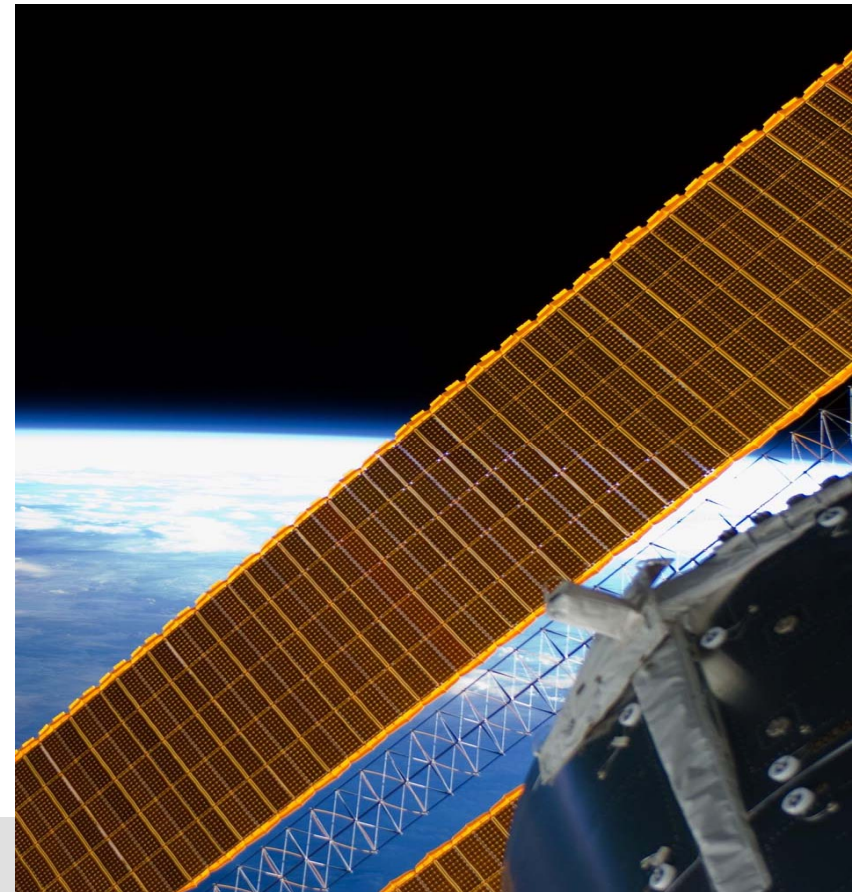


# TECHNOLOGY PROGRAMMES: OBJECTIVES



- **Enabling** missions of ESA and national programmes by developing technology
- Supporting the **competitiveness** of European industry
- Fostering **innovation** by creating new products
- Improve European **technological non-dependence** and the availability of European sources for **critical technologies**.
- Facilitate **spin-in** from outside the space sector

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ESA supports technology development in mandatory programme (TRP, GSP), in dedicated and specific technology segments of optional ESA programmes (CTP for science, EOEP for Earth Observation, FLTP for launchers, ARTES for telecommunications, GNSS evolution, Robotic Exploration, SSA) and in GSTP .

GSTP is a technology programme aiming at bridging the development gap between early technology and in-flight demonstration.

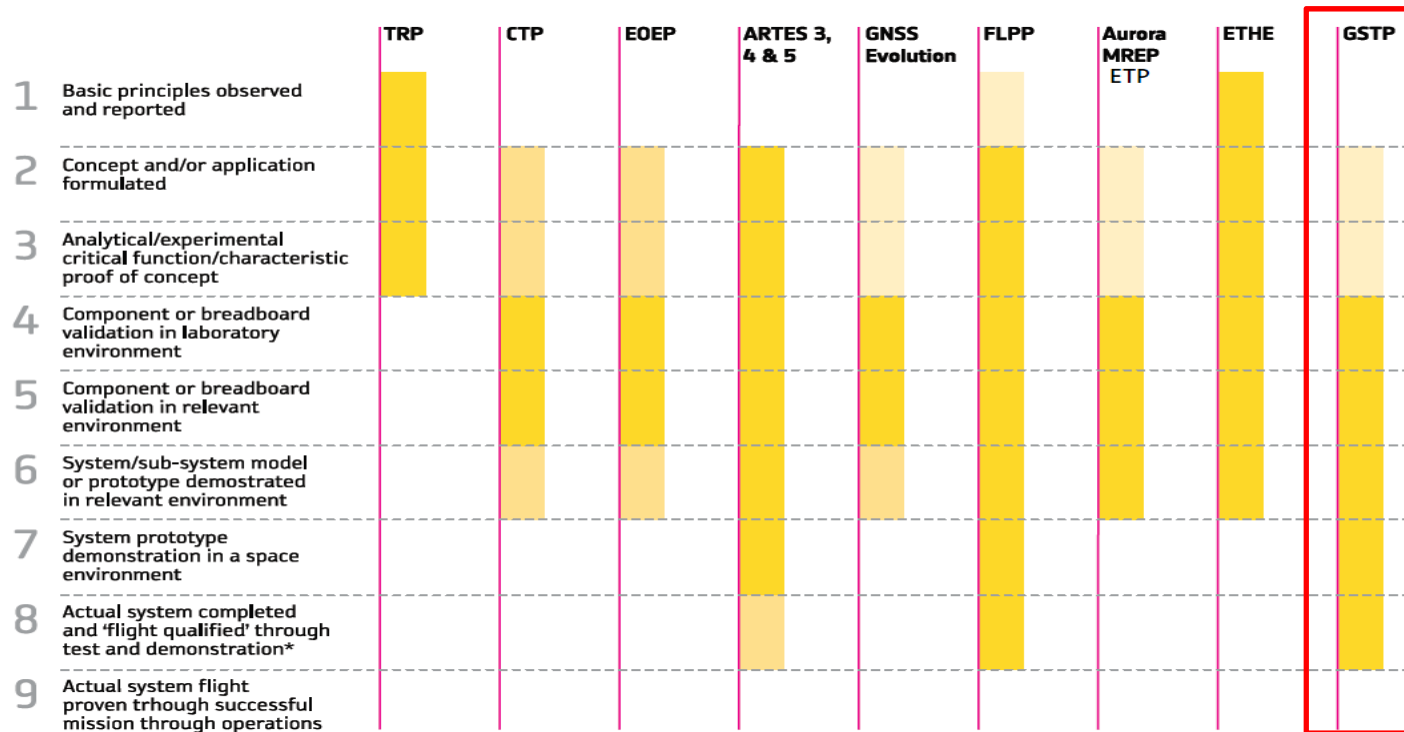
ESA Member States contribute yearly about €150m to the GSTP programme.  
GSTP has different elements with different implementing rules:

- Established work plan with publication of ITT
- Open call
- Mission project
- Fully funded
- Requiring co-funding
- ...

All GSTP projects, except the participation in mission projects requires a written letter from the Delegation authorising the economic operator to bid for that particular activity.



## Technology Readiness Levels



\* Ground or space





# GSTP – GENERAL SUPPORT TECHNOLOGY PROGRAMME

esa

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# GSTP – Overview (1)



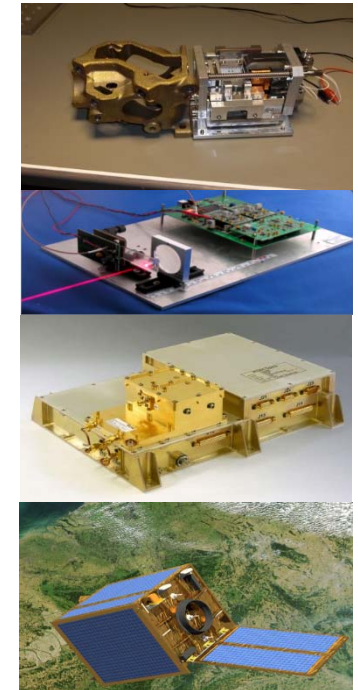
Part of ESA's Optional Programmes.

Covering all technology disciplines and applications except Telecommunications (covered by the ARTES programmes).

Five-year Work Plans, with yearly updates, and multiyear activities.

Started in 1993, currently in 6<sup>th</sup> period (2013-2017)

Initial Budget envelope for GSTP-6 ~ 450 M€, now increased (including transfers from previous periods) to ~ 600 M€.

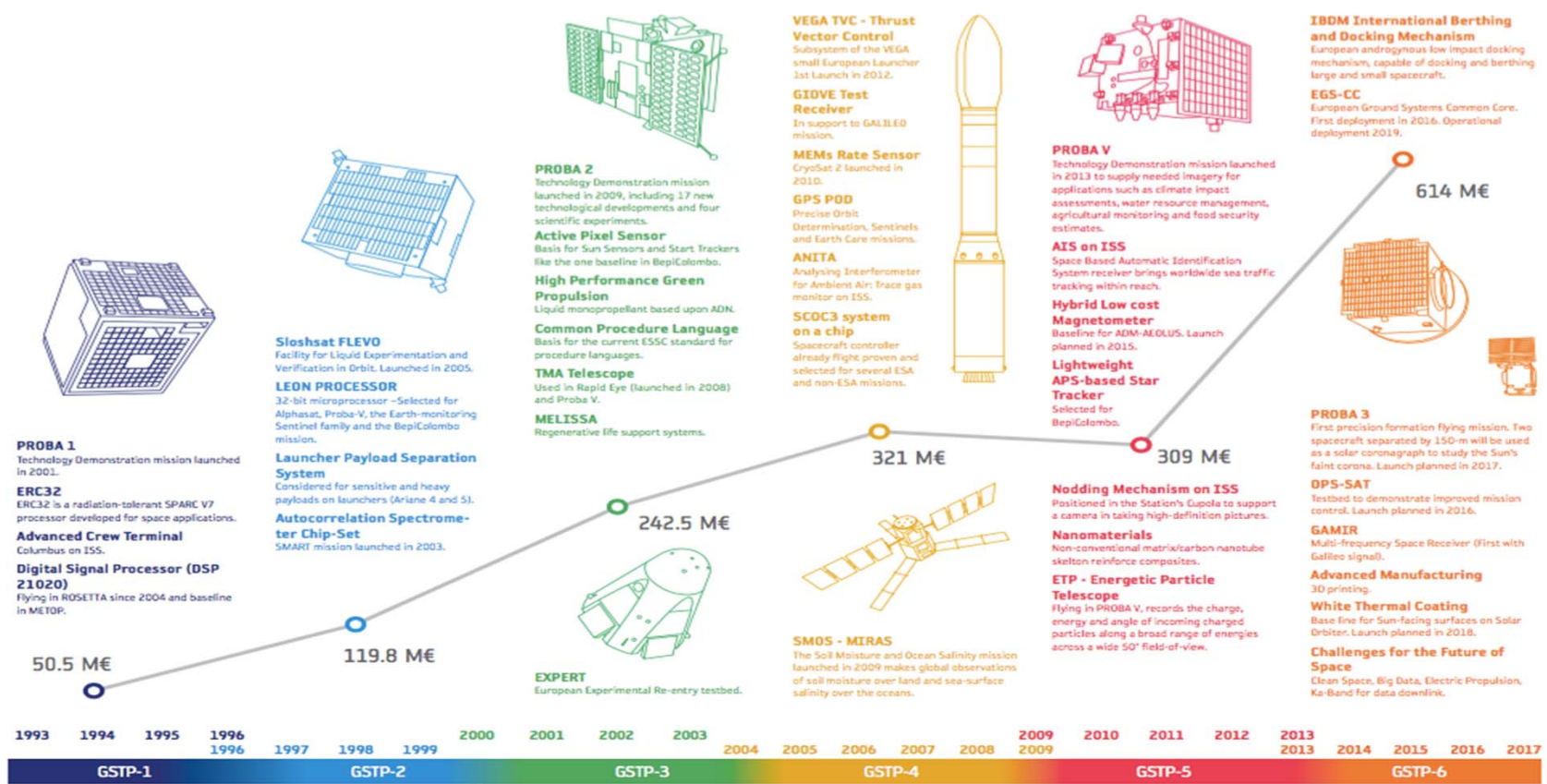


**The GSTP ensures the right technology with the right maturity are available at the right time**





# GSTP – Overview (2)



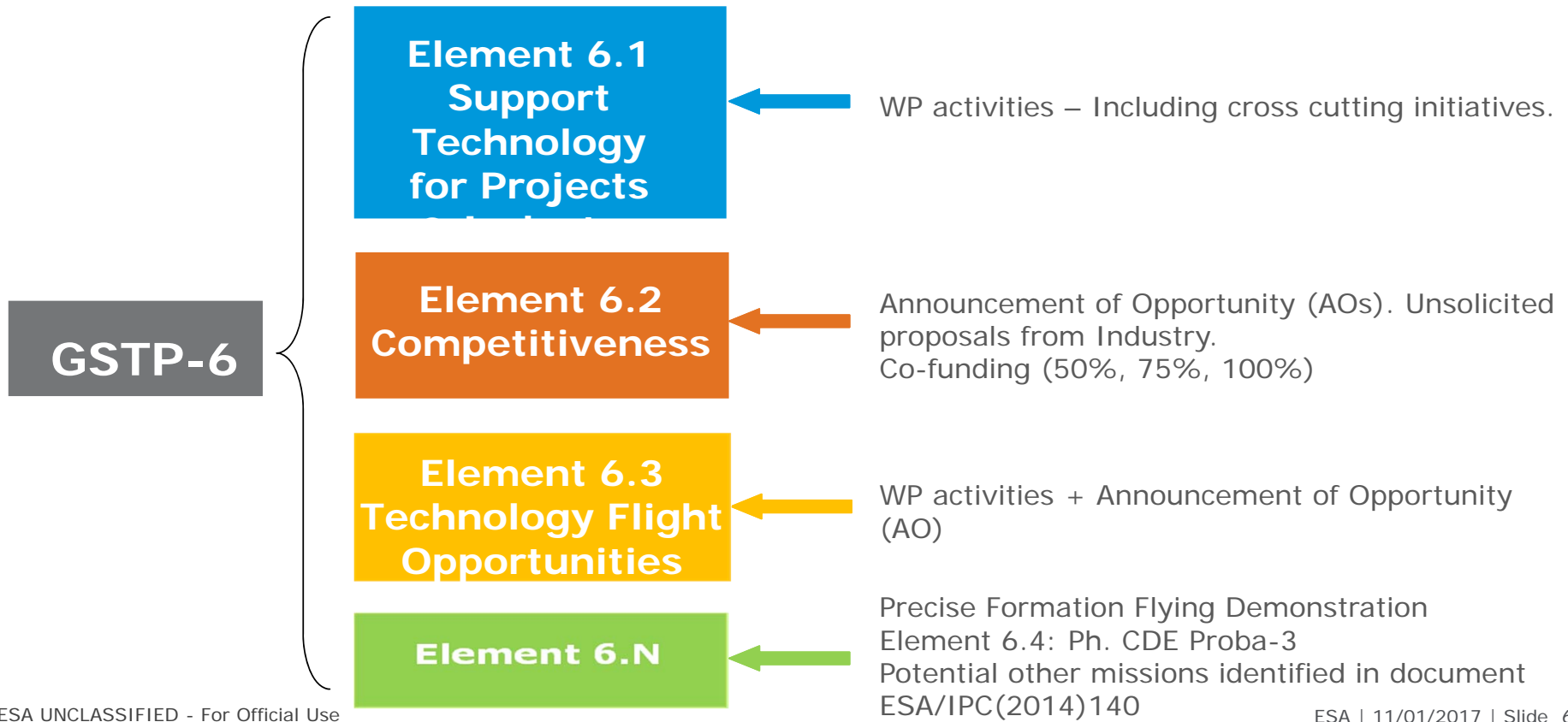
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# GSTP-6 (Former Schema)



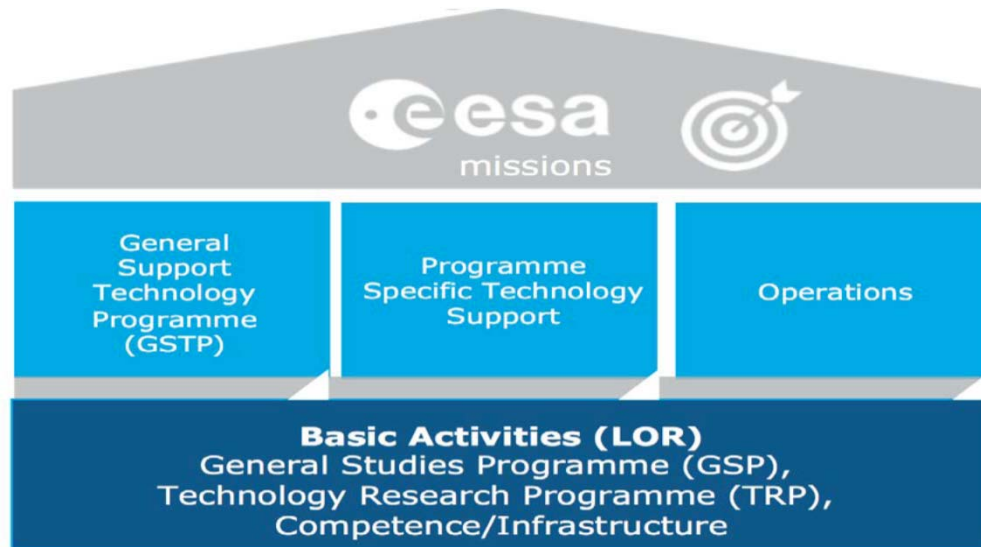
# GSTP overview (New Schema)



Element 1 Develop	Element 2 Make	Element 3 Fly
Industry and projects	Industry and projects	Industry and projects
Development to TRL 7 Phase AB1 of IOD missions	Products to TRL 6/7	Demonstration of experiments in carriers opportunity
Economic operators all Participants	Economic operators participants in Element	Economic operators participants in Element
Work plan, 5 years, updates at least yearly	Permanently open AO	Permanently open
Usually 100 % funding, co- funding possible leading to DN	Industrial research 50%* Experimental development 25%* *Up to 80% for SME depend circumstances Process innovation 50% for SME and 15% for large enterprises providing 30% of work by SME	100 % funded
Clean space, miscellaneous technology, complex GNS and innovative robotics, Energy, ...	Advanced manufacturing, design to produce, environmental regulations, ...	AIM, e-deorbit, smart cubesats, ISS payload, ...
Letters support from Delegation Open competition between supported firms.	Letters support from Delegation Non competitive tender	Letters support from Delegation



# Logic of technology programmes; prepare ESA missions



## ESA technology roadmaps:

Describe future ESA needs in technology development.  
 Issued from technology harmonisation process.  
 Available from the European Space Technologies Master Plan



## ESA technology work plans:

Collect the ESA projects already decided for implementation and already budgeted. Accessible as Intended Invitations to Tender in EMITS.

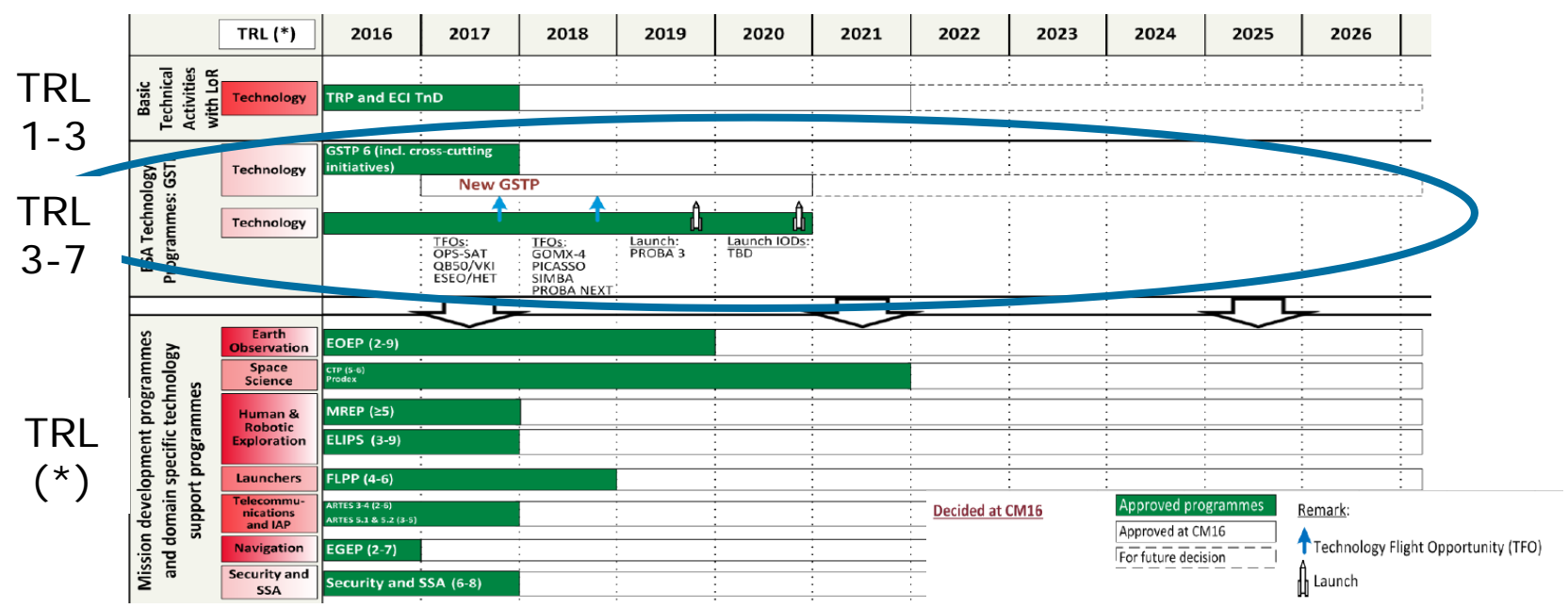
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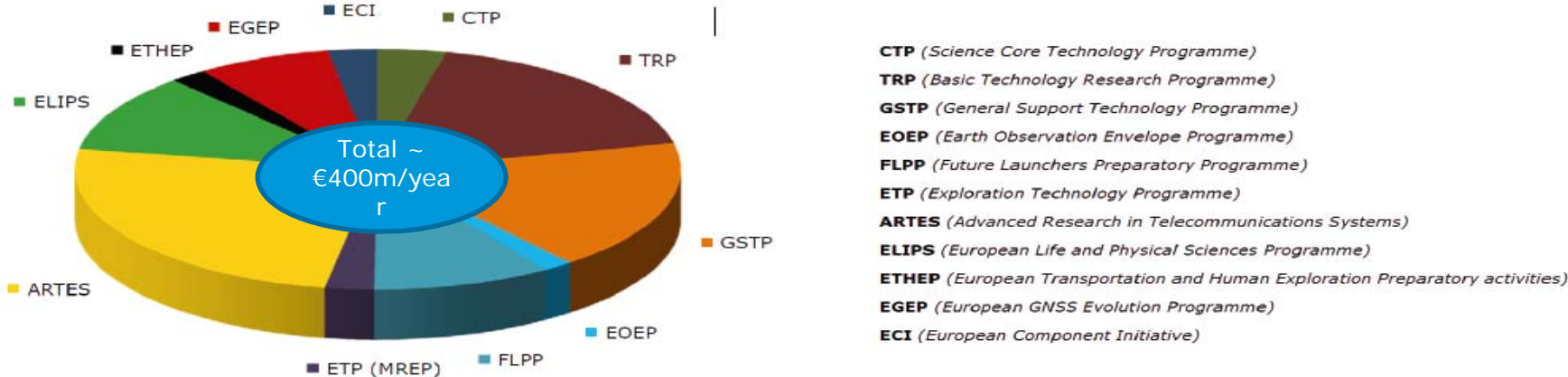
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# Overview of technology programmes in ESA





# Overall ESA R&D approximate budget





# TELECOMMUNICATIONS & INTEGRATED APPLICATIONS

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## A pioneer in telecoms



**1968** – Europe started to develop communications satellites. The **Orbital Test Satellite** (OTS) was launched 10 years later. OTS, and its follow-up ECS, was used for more than 13 years by ESA and Eutelsat.

**Olympus** (1989–93) an experimental satellite, at the time of launch it was the largest civilian telecommunications satellite in the world.

**Artemis** (2001– ) this multi-purpose telecommunications and technology demonstration satellite introduced a new range of telecommunication services to the world.



## Ensuring competitive and innovative industry



ESA's **Advanced Research in Telecommunications Systems** (ARTES) programme promotes the development of technology, products and systems in partnership with industry.

- Helping European industry to compete on the world stage;
- Supporting technological R&D and pioneering developments to bring new technologies near to market readiness;
- Building partnerships capable of creating wealth, jobs and new services for the citizens of Europe;
- Improving our daily lives, from health services to civil protection and rescue operations.



## ARTES partnerships (1)

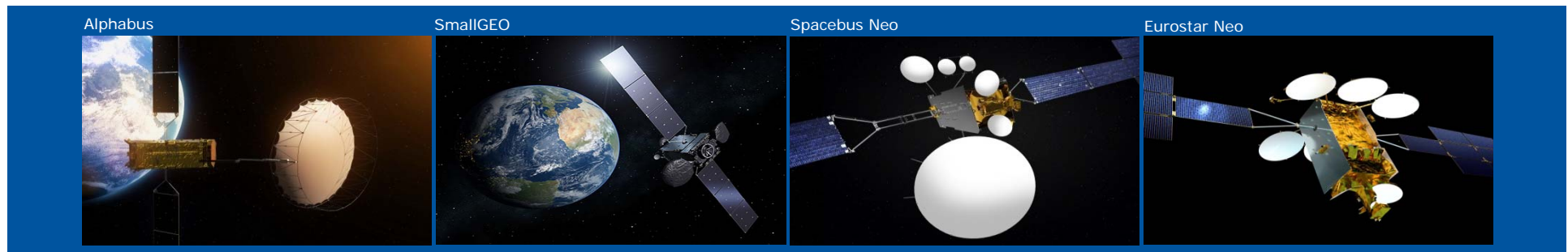


The platform family giving Europe the edge:

**Alphabus** – for the 6-tonne market, with Thales Alenia Space/Airbus D&S (first launch on Inmarsat's Alphasat, 2013)

**SmallGEO** – for the under 3-tonne market, with OHB (first launch on Hispasat AG1, 2016)

**Spacebus Neo** and **Eurostar Neo** – for the 3- to 6-tonne market, with Thales Alenia Space/Airbus D&S (first launches in 2019)



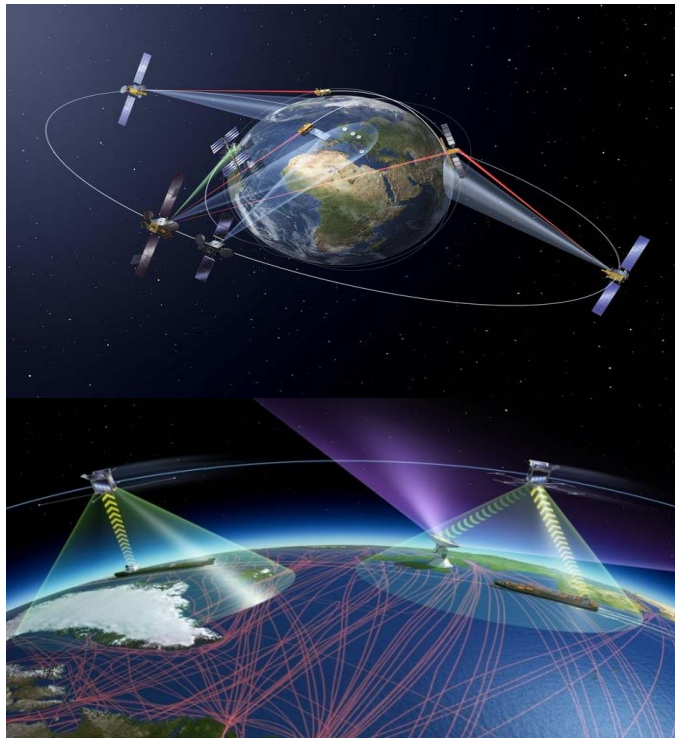
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## ARTES partnerships (2)



### Instant data from space: any place, any time

**EDRS** – the European Data Relay System, or ‘SpaceDataHighway’, an independent space and ground infrastructure that will help to make data gathered anywhere on Earth available in quasi-real time – with Airbus D&S (first launch, 2016; second launch, 2017)

**SAT-AIS** – Data-processing centres and microsattellites equipped with Automatic Identification System (AIS) receivers will make it possible to track seafaring vessels anywhere on Earth, beyond the current limitations of coastal reach – with European Maritime Safety Agency (first launch, 2016)



## ARTES partnerships (3)



### The gamechangers

**Electra** – first fully electric propulsion satellite, with SES (2021)

**Quantum** – in-orbit reprogrammable ‘chameleon’ satellite, with Eutelsat/Airbus D&S (2018)

**Iris** – a new satellite-based aviation communication system, with Inmarsat

**Indigo** – ground-segment innovations, with Intelsat/Newtec

**ICE** – expanding the range of mobile satellite services, with Inmarsat





## ECSAT: European Centre for Space Applications and Telecommunications

- At Harwell, near Oxford (UK), ESA teams work on telecommunications, integrated applications, climate change and exploration.
- An opportunity for ESA to enhance transfer of innovative R&D activities to a commercially oriented community.
- ECSAT is built around maximum benefit from cooperation with organisations located on or linked to the Harwell Campus.



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# “Standard” Telecommunications activities



ARTES Future Preparations	ARTES Advanced Technology	ARTES Competitiveness and Growth	Integrated Applications Promotion (IAP)
Strategy	Core Telecom Technology	Core world competitiveness	Integrated applications
Mission, system and General configuration studies to prepare and update ESA telecom programme	Development technologies and techniques (max to EM level). Flight and ground, system and equipment.	Development products to QM and in flight demonstration. Mega-constellation opportunity.	Awareness, studies, appl. Attracting new user communities. Services, establishing partnerships with powerful financial players beyond ESA
	Yearly work plans	Permanently open AO	Yearly work plan
All ARTES participants	Participants in Element	Participants in Element	Participants in Element
Open	Open	Industry proposals, aligned with the commercial plan of industry	Open
100 % funded	100 % funded	50 % funded	50 % funded
	Letter of support	Letter of support	Letter of support

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# Future possible opportunity missions



**Globe net:** Shall complete EDRS constellation

**GOVSATCOM Precursor:** Support the European industry to develop European based technology solutions to respond to the requirements of a future EC and EDA operational programme.

**Pioneer:** Support to commercial one-shop service providers interested in providing affordable in orbit demonstration/validation of innovative services



# Public Private Partnerships (PPP)



By its nature the preparation of future PPP is keep confidential; recalling past and on going ones:

**Alfasat (completed):** large GEO satellite using the European bus Alfabus. Participation of telecommunication operator and 2 European prime contractors. The participation of member states in the programme based on specific industrial contributions. The State contribute in function of what the national industry gets as activity.

**Smallgeo (launch 2016):** Small GEO satellite platform

**Electra:** All electrical geo-stationary satellite. Cooperation prime-operator.

**SAT AIS:** European – Canadian AIS constellation

**EDRS (launch 2016 – 2017):** Data relay structure for Europe

**Neosat:** New telecom platform in cooperation with telecom operator. Opportunities for countries to contribute if industry finds a job in the project.

**ICE:** New generation of L band system for mobile telecommunications

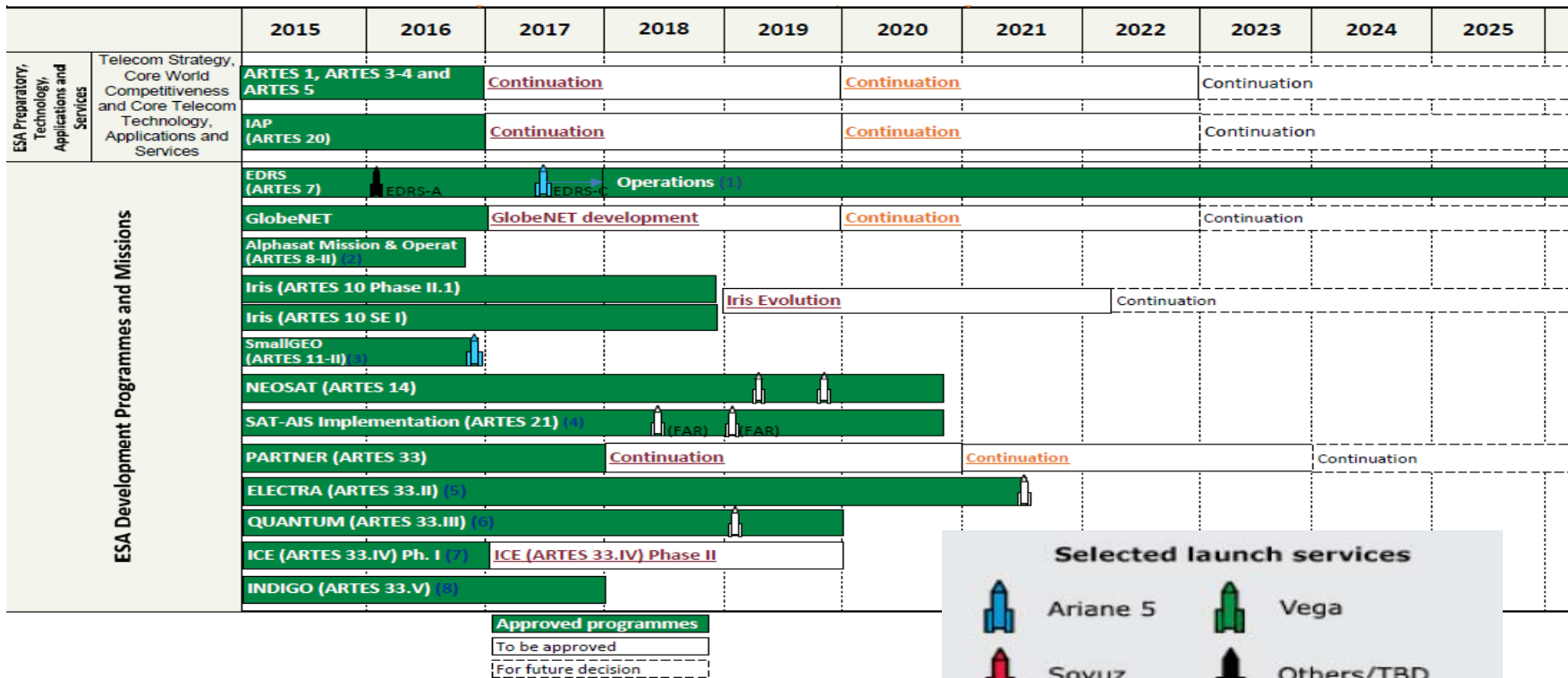
**IRIS:** Support to EC effort for the modernisation of ATM. Possible contribution to GOVSATCOM

**Quantum:** In orbit re-programable satellite

**Indigo:** Ground segment innovations



# Overall schedule for telecommunication programme



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# NAVIGATION

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## Galileo: “made in Europe”



Galileo constellation is being deployed and will be operated by EC providing opportunities for downstream services development.

The continuation of the European GNSS programmes' evolution and preparatory activities is encompassed as part of H2020 (HSNAV) and the implementation delegated to ESA by the European Commission. Therefore, EC procurement rules will apply and in particular no geographical return obligation.

An average yearly figure of €500m are expected to be managed by ESA on behalf of EC and GSA (European GNSS Agency).





## Galileo: “made in Europe”



Putting Europe at the forefront of this strategically and economically important sector, **Galileo** will provide a highly accurate, guaranteed global positioning service under civilian control. The full Galileo system will consist of 30 satellites and the associated ground infrastructure. Galileo is a joint initiative between ESA and the European Union.

**GIOVE-A** (2005–12) Galileo test satellite

**GIOVE-B** (2008–12) validated technologies

**Galileo IOV** (2011/12) In-orbit Validation satellites (2+2 satellites)

**FOC** (2014 –) Full Operational Capability (30 satellites). Early services available from 2016.



# EGNOS and Galileo applications



- Since 2010, **EGNOS** has been improving accuracy and augmenting GPS, offering safety-critical applications for aviation users.
- **Galileo** is expected to spawn a wide range of applications, based on positioning and timing for transport by road, rail, air and sea, infrastructure and public works management, agricultural and livestock management and tracking, e-banking and e-commerce.
- It will be a key asset for public services, such as rescue operations and crisis management.
- In November 2012, the **European GNSS Evolution Programme** for 2013–15 was approved, for the next versions of EGNOS, Galileo satellites and preparing future services.



# NAVISP Programme



ESA will continue supporting the generation of innovative Satellite navigation -and more broadly Positioning Navigation Timing (PNT) technologies and services- in the frame of ESA NAVISP programme aiming at positioning the European industry in the emerging worldwide commercial navigation market. An average of €20m per year are expected to invest ESA in the NAVISP programme.

The NAVISP programme will be managed using ESA procurement rules.

Within NAVISP element 3, ESA will provide technical support to national activities of individual ESA Member States

Up to 2016, ESA was investing average of €45m per year in the European GNSS evolution programme.



# NAVISP PROGRAMME STRUCTURE AND CONTENT



	<b>ELEMENT 1 [Innovation in Satellite Navigation]</b>	<b>ELEMENT 2 [Competitiveness]</b>	<b>ELEMENT 3 [Support to Member States]</b>
<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, 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 in coordination with EC/GSA</b>	<b>Industry</b>	<b>Member States</b>





# HUMAN SPACEFLIGHT

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# International Space Station (ISS)



The ISS unites USA, Russia, Japan, Canada and Europe in one of the largest partnerships in the history of science. Crews of up to six astronauts conduct research into life and physical sciences and applications, and prepare for future human exploration missions.

Europe's two key contributions are the **Columbus** laboratory and the **Automated Transfer Vehicle** (ATV). Columbus provides a substantial part of the ISS's research capability, specialising in fluid physics, materials science and life sciences. Europe has also provided almost 50% of the pressurised part of the ISS, including **Cupola**, **Node-2** and **Node-3**.



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## European Service Module



The **European Service Module (ESM)** is ESA's contribution to NASA's **Orion** spacecraft that will send astronauts to the Moon and beyond. The spacecraft comprises the ESM and the US Crew Module.



The ESM resembles ESA's **Automated Transfer Vehicle**, from which it evolved. Between 2009 and 2014, five Automated Transfer Vehicles delivered supplies to the International Space Station and helped to keep the outpost in orbit.

The first mission for the complete **Orion** spacecraft will be an unmanned flight to the Moon and back (first launch, 2017)



## Europeans in space



The first ESA astronauts were selected in 1978:



Ulf Merbold  
(DE)



Wubbo Ockels  
(NL)



Claude Nicollier  
(CH)

The European Astronaut Corps was formed in 1998, uniting astronauts of several Member States, including



Michel Tognini  
(FR)



Jean-Pierre Haigneré  
(FR)



Umberto Guidoni  
(IT)



Maurizio Cheli  
(IT)



Claudie Haigneré  
(FR)



Gerhard Thiele  
(DE)

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# Flight-experienced astronauts



Currently active or on other assignment:



Christer Fuglesang  
(SE)



Reinhold Ewald  
(DE)



Jean-François Clervoy  
(FR)



Pedro Duque  
(ES)



Léopold Eyharts  
(FR)



Hans Schlegel  
(DE)



Thomas Reiter  
(DE)



Frank De Winne  
(BE)



Paolo Nespoli  
(IT)



Roberto Vittori  
(IT)



André Kuipers  
(NL)



## Next generation: flown and in training



Based at the **European Astronaut Centre (EAC)**, Cologne, Germany:

Luca Parmitano (IT), Alexander Gerst (DE) and Samantha Cristoforetti (IT) flew to the ISS in 2013, mid-2014 and end-2014 respectively.

Andreas Mogensen (DK) flew in 2015, Tim Peake (UK) is flying in 2015/16, and Thomas Pesquet (FR) will fly in 2016.



Back: Tim, Andreas, Alex, Luca; front: Samantha, Thomas





## Robotic exploration

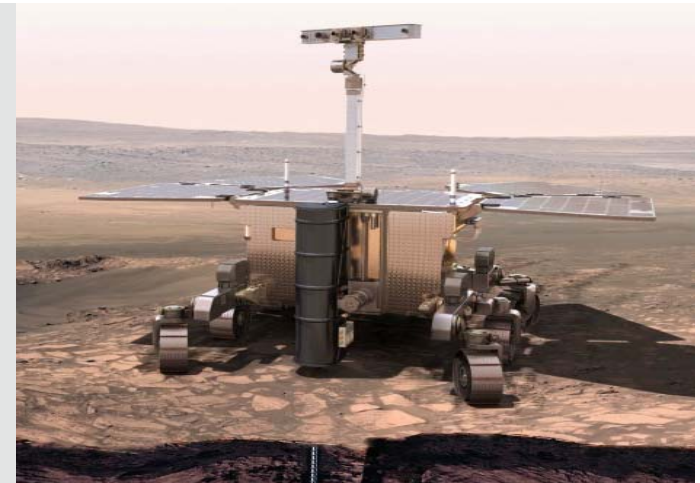


In cooperation with Roscosmos (Russia), two **ExoMars** missions (2016 and 2018) will investigate the martian environment, particularly astro-biological issues, and develop and demonstrate new technologies for planetary exploration with the long-term view of a future Mars sample return mission.



ESA will provide the **Trace Gas Orbiter** and the **Entry, Descent and Landing Demonstrator Module** in 2016, and the **carrier** and ExoMars **rover** in 2018.

Roscosmos will be responsible for the 2018 descent module and surface platform, and will provide Proton launchers for both missions. Both partners will supply scientific instruments and will cooperate closely in the scientific exploitation of the missions.





# European Exploration Envelope Programme



European Exploration Envelope Programme (E3P) will until 2019 continue honouring the European commitments in ISS including astronauts provision, development and production of the Service Module of the Multipurpose Crew Vehicle and support to ISS utilisation.

Operation and data exploitation of ExoMars will continue and exploitation of Russian Luna-Resource lander may begin.

Science in Space element of E3P will support research in ISS and non-ISS space platforms and analogue environments, this will be the continuation of the current ELIPS programme where experiments and payloads for microgravity research are developed, including procurement of suborbital launchers launched from Kiruna, parabolic flights and drop tower experiments.

The ExPeRT element (Exploration Preparation, Research and Technology) will develop exploration technologies and concepts in preparation of new projects in human and robotic exploration and will contribute to the consolidation of exploration missions international partnerships. ExPeRT includes the continuation of the current MREP programme.

Commercial partnerships in European space exploration will help European actors to develop new types of special commercial activities.





# BASIC TOOLS. LAUNCHERS & OPERATIONS

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## The European launcher family



The **Ariane** and **Vega** launchers developed by ESA guarantee European autonomous access to space.

Their development and successful exploitation is an example of how space challenges European industry and provides precious expertise.

**Ariane** is one of the most successful launcher series in the world. Complemented since 2011 by **Vega** and **Soyuz**, they are all launched from Europe's Spaceport in French Guiana.



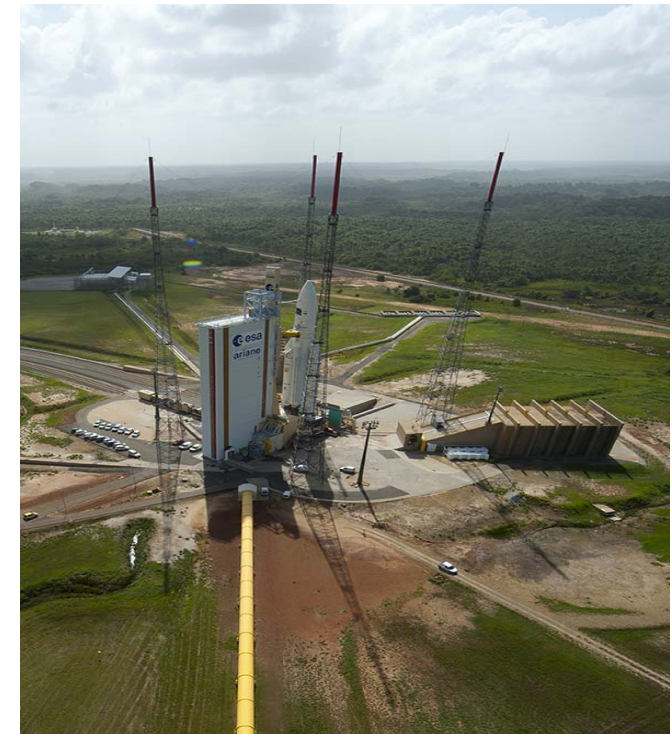
## Europe's spaceport



European launchers lift off from the Centre Spatial Guyanais (CSG), Kourou, in French Guiana.

The CSG launch range is co-funded by ESA and France and is operated by the French space agency CNES.

The launch infrastructure for the **Ariane 5**, **Vega** and **Soyuz** launchers at CSG is owned by ESA, maintained and operated by Arianespace, with the support of European industry.





## Launchers and technologies of the future: Ariane 6 and Vega C



European Ministers agreed at the Ministerial Council 2014 to develop **Ariane 6** and **Vega C**. These launchers will provide guaranteed access to space for Europe at a competitive price without requiring public sector support for commercial exploitation.

- Ariane 6 - modular three-stage launcher with two configurations, using two (A62) or four boosters (A64);
- Vega C - evolution of Vega with increased performance and same launch service cost;
- Common solid rocket motor for Ariane 6 boosters and Vega C first stage;
- New governance for Ariane 6 development and exploitation allocating increased roles and responsibilities to industry;
- Vega C and Ariane 6 first flights - 2019 and 2020.



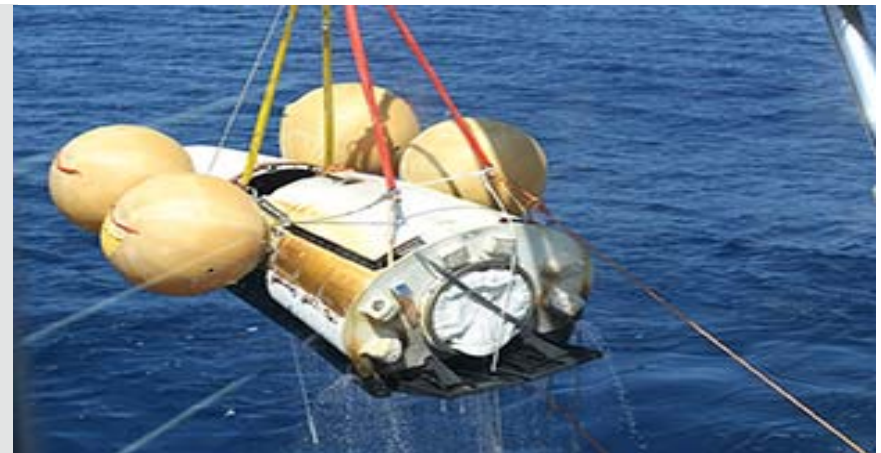


## Launchers and technologies of the future: IXV and PRIDE



The **Intermediate eXperimental Vehicle** (IXV) project:

- Tackles the basic needs for reentry from Low Earth Orbit, consolidating the knowledge necessary for the development of any future European reentry system.
- Launched on a Vega rocket in 2015. After reentering Earth's atmosphere and being slowed down by air drag, IXV descended by parachute and landed successfully in the Pacific Ocean for recovery and post-flight analysis.



**PRIDE**, a follow-on mission is in preparation: an integrated space transportation system based on Vega C, to enable a European independent capability to routinely access and return from low Earth orbit with a reusable system.



## Mission operations

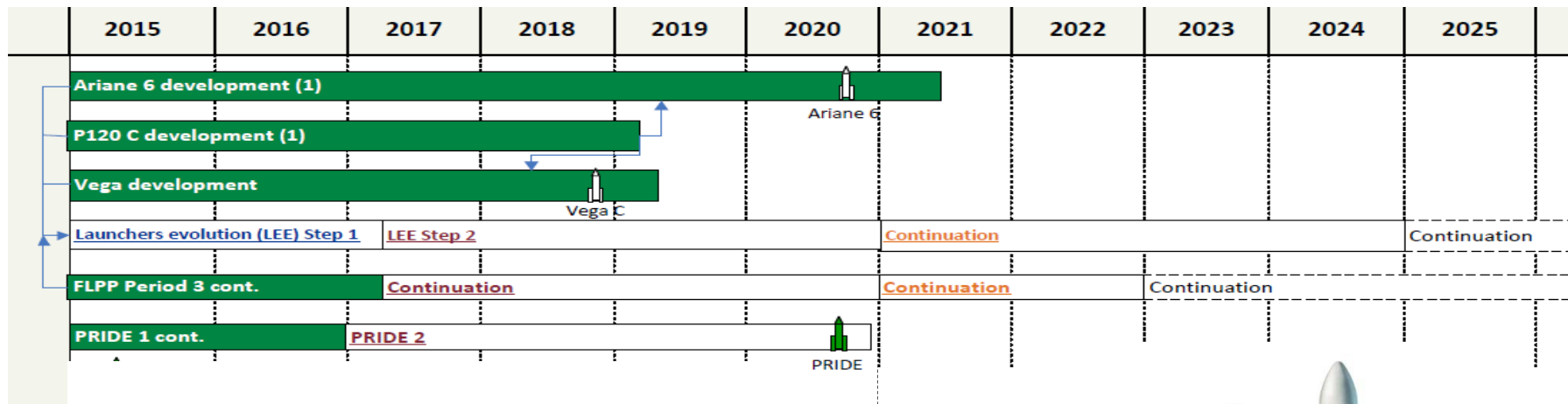


**ESOC** (Darmstadt, Germany) is ESA's centre for mission operations and ground systems engineering.

- Preparation and execution of combined ground- and space-segment operations
- Mission control systems, ground stations and operational communication and computer systems
- Operation of spacecraft and ground facilities, mission analysis, flight dynamics and navigation



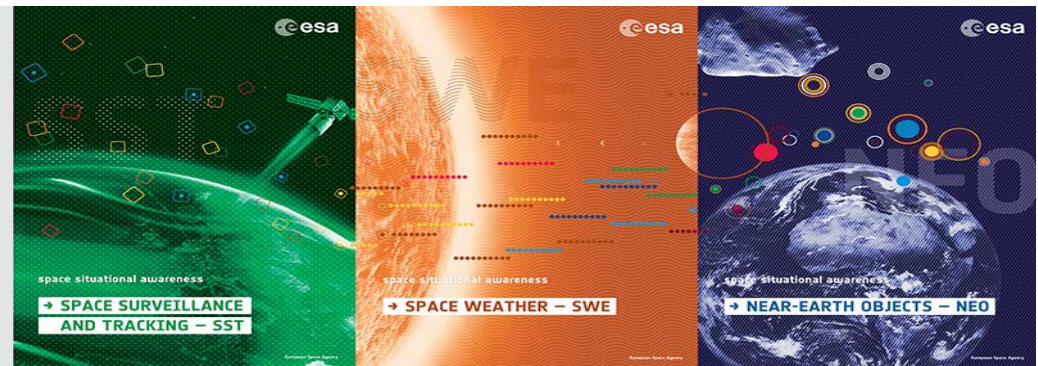
# Launcher programmes



# Space Situational Awareness



The **Space Situational Awareness (SSA)** initiative aims to provide Europe with services to protect satellites and Earth.



The initiative supports Europe's independent utilisation of space, through provision of timely and accurate information about the space environment. SSA will strengthen reliability, availability and security of Europe's space-based services.

It will be coordinated with international partners and the institutions of the European Union.

European industry will benefit from new contracts and world-class competitive capabilities gained through development of the SSA infrastructure and services.





# ESA AND ITS INTERNATIONAL PARTNERS

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# Strong ties all over the world



## Partnership: one of ESA's key words

As a European research and development organisation, ESA is a programmatically driven organisation, i.e. the international cooperation is driven by programmatic needs and rationale.

- **Strategic partnerships** with: USA, Russia and China
- **Long-standing cooperation** with Japan, India, Argentina, Brazil, Israel, South Korea, Australia and many more...
- **EU Members, but not ESA Member States:** enhanced cooperation and joint activities. European Cooperating States (ECS): Bulgaria, **Latvia**, Lithuania, Slovakia and Cyprus. Cooperating State: Malta.
- Discussions are ongoing with Croatia.





# ESA AND THE EUROPEAN UNION

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# Space for Europe



The European Union and ESA share a common aim: to strengthen Europe and benefit its citizens.



Closer ties and an increased cooperation between ESA and the EU bring substantial benefits to Europe by:

- guaranteeing Europe's full and unrestricted access to services provided by space systems for its policies,
- encouraging the increasing use of space to improve the lives of its citizens,
- increasing political visibility of space and taking full benefit from its economic and societal dimension.



# Cooperation with the EU



- The Lisbon Treaty of 2009 reinforces the case for space in Europe and strengthens the role of ESA as an R&D space agency. Article 189 of the Treaty gives the EU a mandate to elaborate a European space policy and take related measures, and provides that the EU should establish appropriate relations with ESA
- ESA/EU Framework Agreement in force and extended to 2016
- ESA/EU Space Council ministerial-level meetings and related resolutions provide directions and guidelines
- Two flagship programmes: Galileo, Copernicus
- Arrangement with the European Defence Agency for cooperation on space and security
- Political Declaration by Ministers in November 2012 gave ESA DG the mandate to reflect 'towards the European Space Agency that best serves Europe', starting a process for the further evolution of ESA
- Resolution on ESA evolution, covering the vision for ESA until 2030, as agreed at ESA Ministerial Council 2014



# European space policy



Strategic objectives of space for Europe:

- develop space applications to serve Europe's public policies, enterprises and citizens;
- meet Europe's security and defence needs;
- foster competitive and innovative industries;
- contribute to the knowledge-based society;
- secure access to technologies, systems and capabilities for independence and cooperation.

In May 2007, 29 European countries (17 Member States of ESA and 27 Member States of the EU) adopted a Resolution on the European Space Policy, adding a new dimension to European space activities.





**Thank you for your attention**

European Space Agency