The European Space Agency
An overview

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Croatian heart-shaped island of Galešnjak

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ESA facts and figures

- Over 50 years of EXPERIENCE
- From 11 to 22 Member States
- Eight facilities in Europe, about 2300 staff
- 5.7 billion Euro budget (2019)
- Almost 100 satellites designed, tested and operated in flight
- ‘coopetition’ : as space is powered by competition but enabled by cooperation, over 500 agreements were concluded since 1975
- Circa 500 satellites/probes sent by Ariane since 1979, or Vega after 2012, from Europe’s spaceport (Kourou)

Purpose of ESA

"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

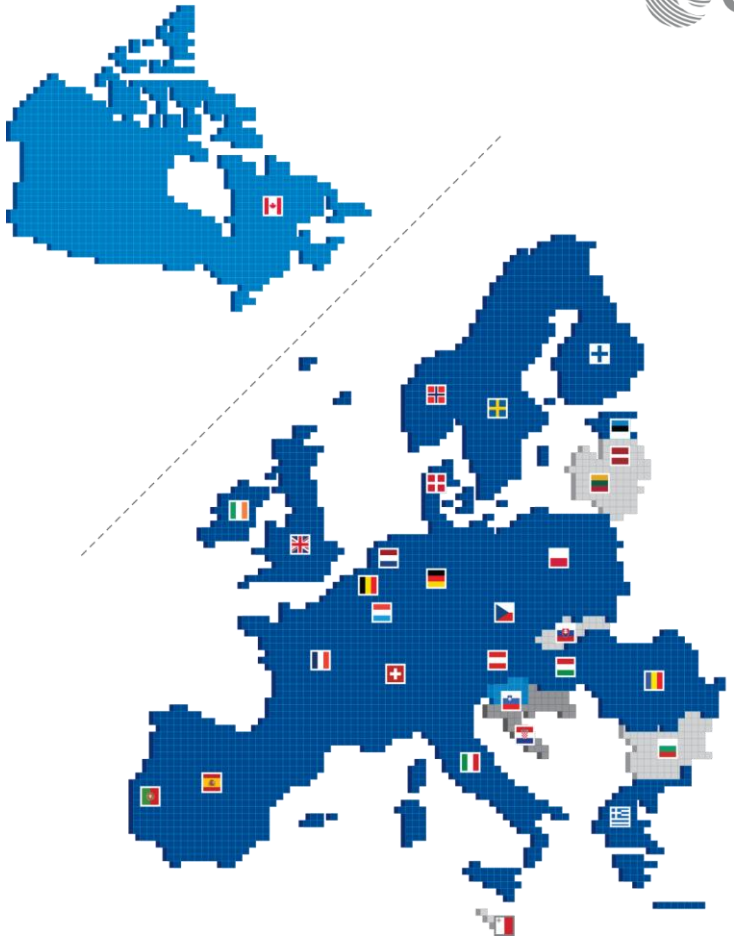
Established in 1975, succeeding ESRO and ELDO, ESA currently has 22 Member States

20 states of the European Union, plus Norway and Switzerland

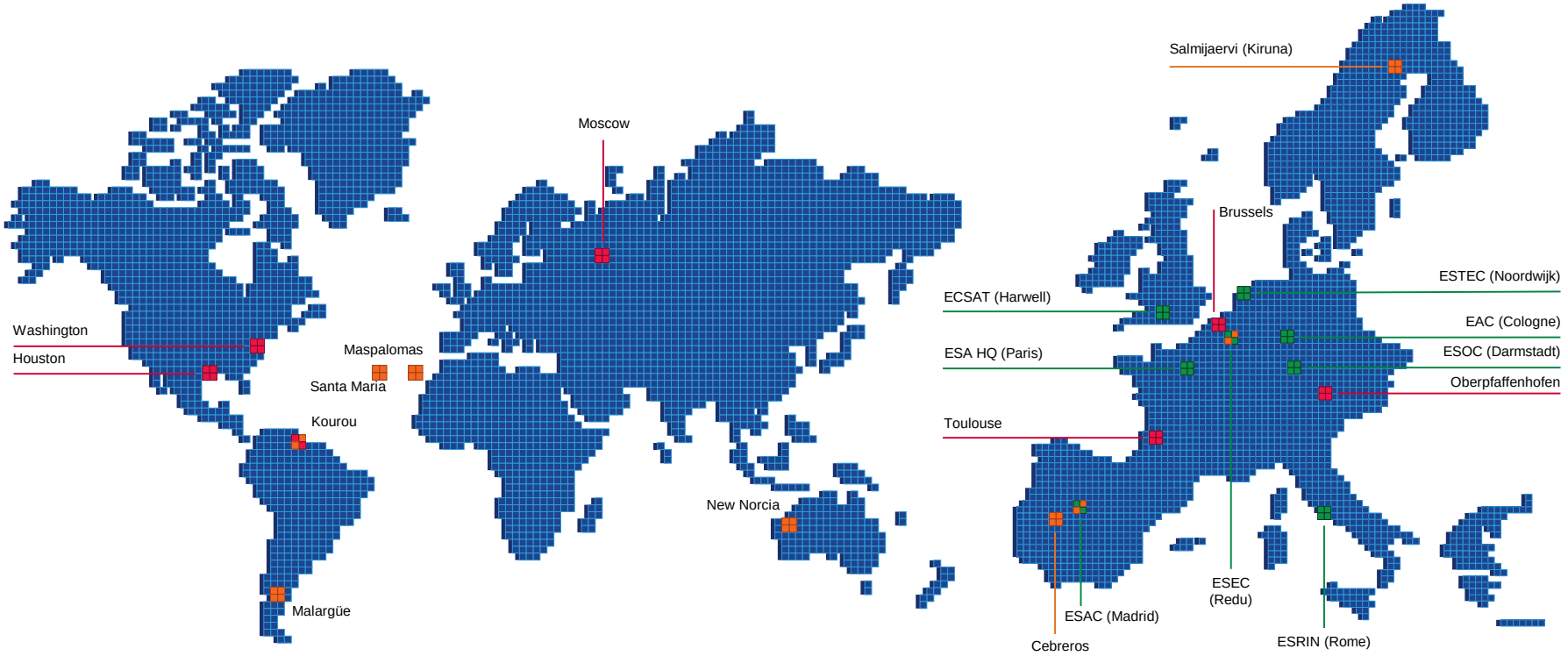
By order or ratification, from 1976 to 2015:

Sweden, Switzerland, Germany, Denmark, Italy, United Kingdom, Belgium, The Netherlands, Spain, France, Ireland, Austria, Norway, Finland, Portugal, Greece, Luxembourg, Czech Republic, Romania, Poland, Estonia, Hungary

Canada takes part in some programmes under a long-standing Cooperation Agreement, since 40 years (1979-2019).



ESA’s locations

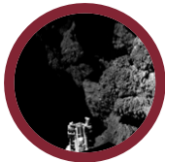


- ESA sites
- Offices
- ESA Ground Station
- ESA Ground Station + Offices
- ESA sites + ESA Ground Station

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


operations


space transportation


navigation

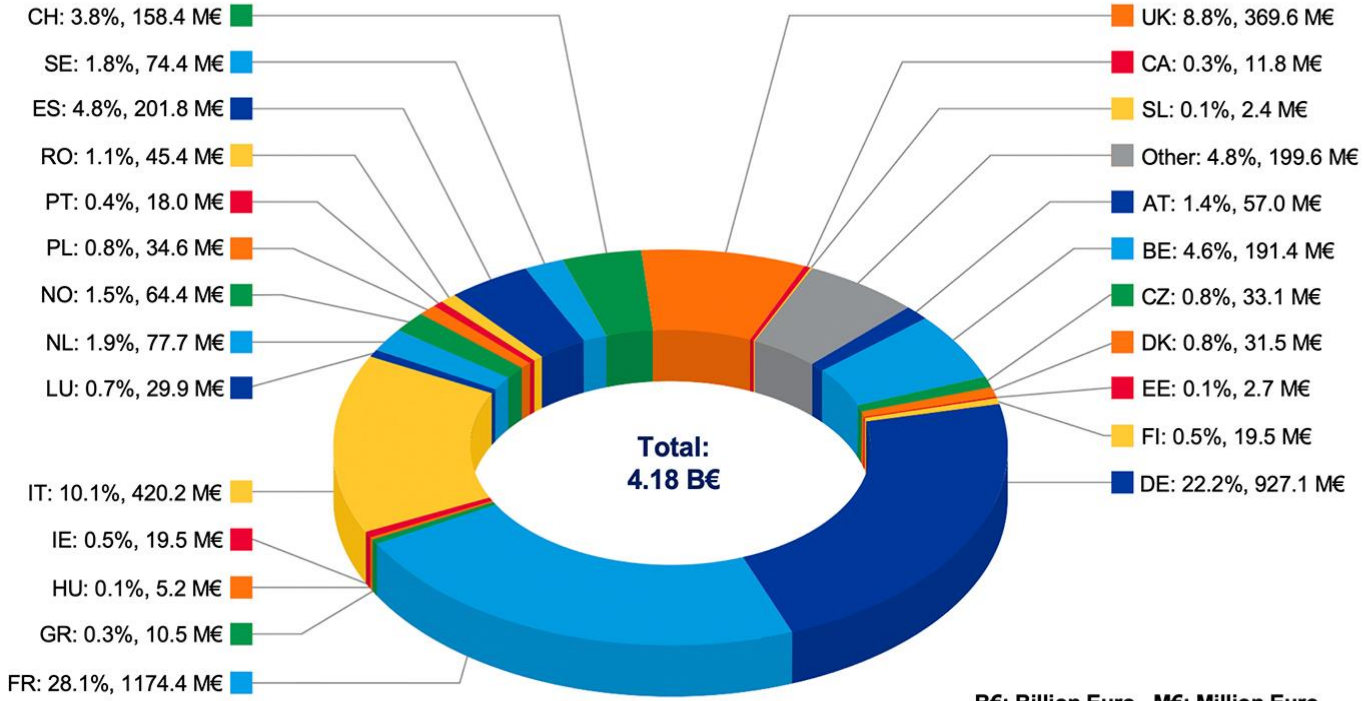

technology


earth observation


telecommunications

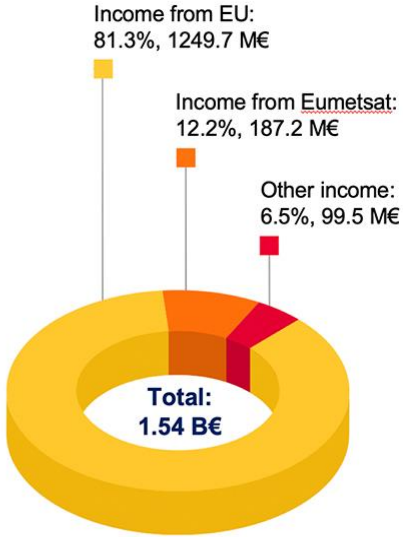
ESA budget for 2019: 5.72 B€

ESA Activities and Programmes

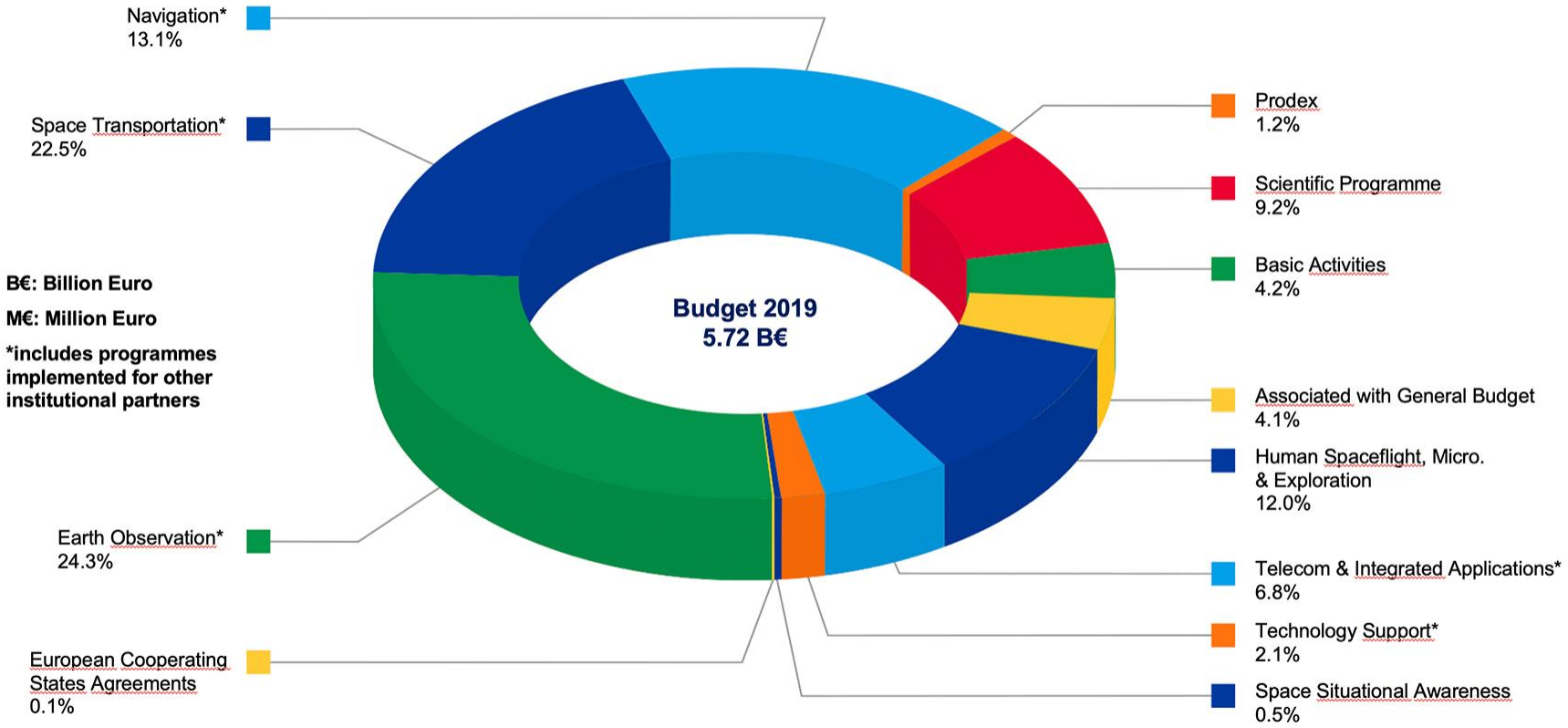


B€: Billion Euro M€: Million Euro

Programmes implemented for other institutional partners



ESA budget by domain for 2019: 5.72 B€



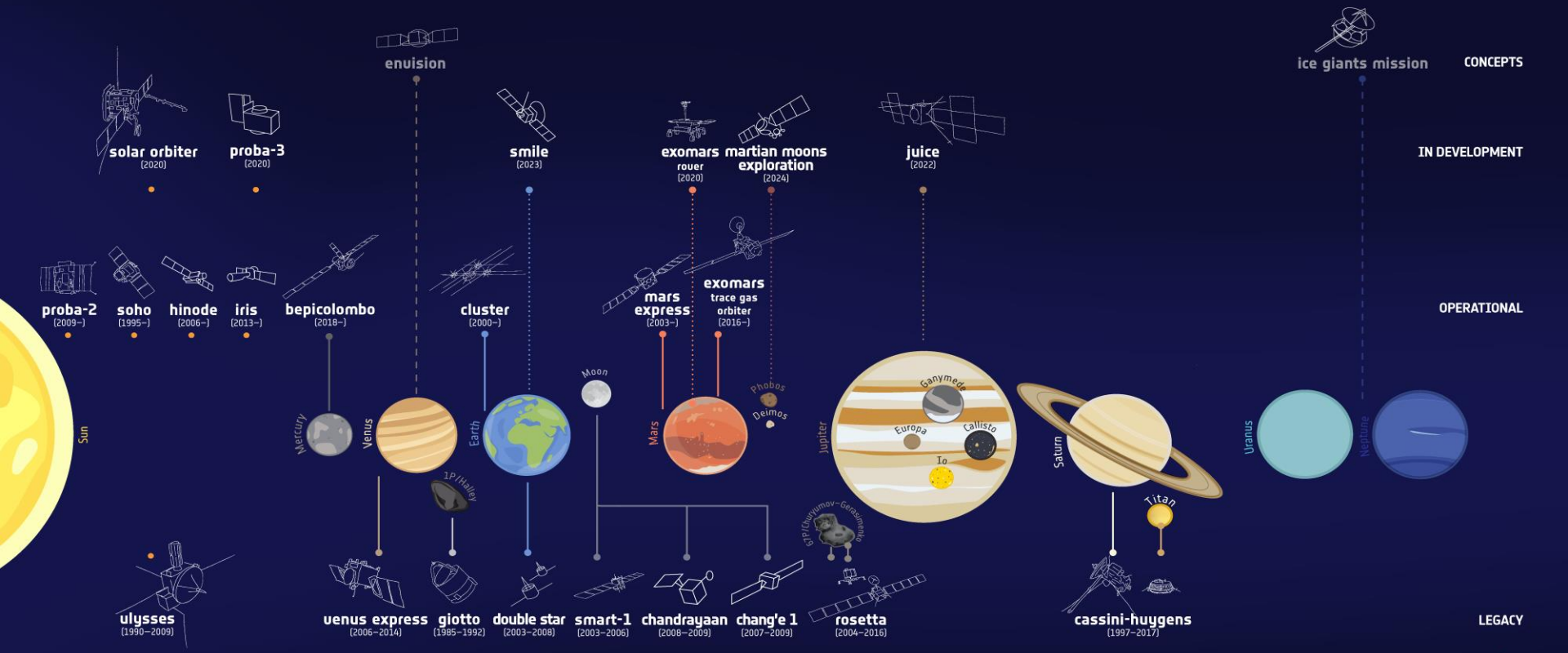
industrial policy

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.

→ SOLAR SYSTEM EXPLORERS



#Space19plus

Space19

European Space Agency

→ COSMIC OBSERVERS

esa

CONCEPTS

IN DEVELOPMENT

OPERATIONAL

LEGACY

spica

theseus

webb (2021)

ariel (2028)

euclid (2022)

cheops (2019)

plato (2026)

xrism (2021)

einstein probe (2022)

athena (2031)

lisa (2034)

hubble (1990–)

gaia (2013–)

xmm-newton (1999–)

integral (2002–)

microwaves | *sub-millimetre* | *infrared* | *optical* | *ultraviolet* | *x-rays* | *gamma rays* | *gravitational waves*

planck (2009–2013)

herschel (2009–2013)

iso (1995–1998)

akari (2006–2011)

hipparcos (1989–1993)

corot (2006–2014)

iue (1978–1996)

exosat (1983–1986)

hitomi (2016)

suzaku (2005–2015)

cos-b (1975–1982)

lisa pathfinder (2015–2017)

microscope (2016–2018)

#Space19plus

Space19

European Space Agency

European Exploration Envelope (E3P)

In response to the Resolution on Europe's Space Exploration Strategy adopted in Luxembourg in December 2014, exploration activities were consolidated in a single European Exploration Envelope Programme (E3P) integrating the three ESA exploration destinations 'as part of a single exploration process'. Its main activities cover:

- International Space Station – Operations until 2024
- ExoMars – Trace Gas Orbiter and 2020 rover mission
- Luna-Resource Lander – Contributions to Russian-led Luna-Resource Lander, Luna 27 (2021)
- European Service Module – First Orion flight (June 2020) and second flight model (TBC)
- Future Human Exploration
- SciSpacE – Science in Space Environment
- ExPeRT – Exploration Preparation, Research and Technology

Next generation: flown and in training

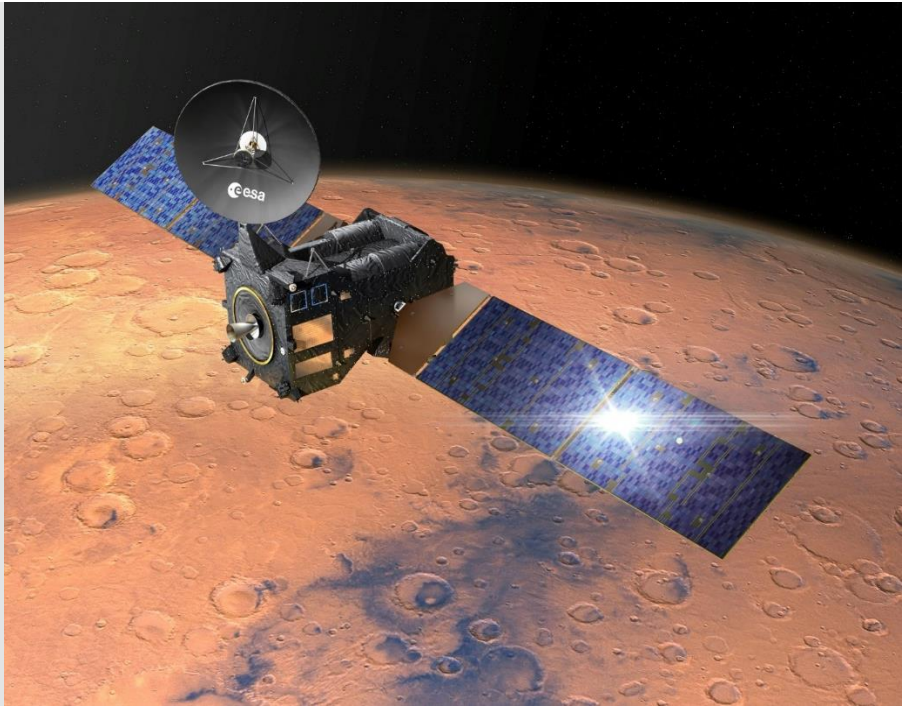
Based at the European Astronaut Centre (EAC), Cologne, Germany

Samantha Cristoforetti (IT) flew to the ISS end-2014.
Andreas Mogensen (DK) flew in 2015
Tim Peake (UK) in 2015/16
Thomas Pesquet (FR) in 2016/17
Alexander Gerst (DE) flew to ISS mid of 2014 and was the Commander of the ISS mid of 2018.
Luca Parmitano (IT) flew to the ISS in 2013 and will fly again in July 2019
Matthias Maurer (DE) began training in 2017

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

Robotic exploration

In cooperation with Roscosmos (Russia), two ExoMars missions (2016 and 2020) 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.



Earth Explorers

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

Earth Explorers 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 (2018–) studying global winds
- EarthCARE (2021) studying Earth's clouds, aerosols and radiation (ESA/JAXA)
- Biomass (2021) studying Earth's carbon cycle
- FLEX (2022) studying photosynthesis
- Earth Explorers 9 & 10 to be selected

Global monitoring for a safer world

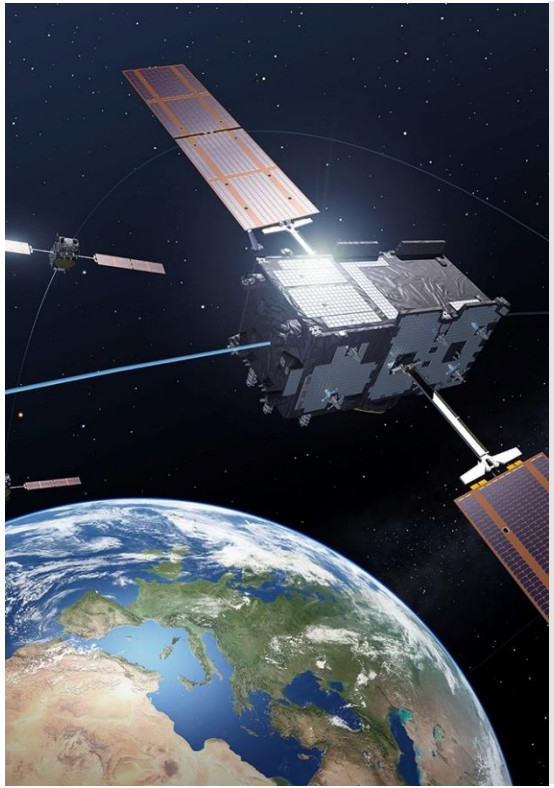
Copernicus: an Earth observation programme for global monitoring for environment and security

Led by the EC in partnership with ESA and the European Environment Agency. ESA is implementing the space component: developing the Sentinel satellite series, its ground segment & coordinating data access

- Sentinel-1 – land and ocean services. Sentinel-1A launched in 2014/Sentinel-1B in 2016
- Sentinel-2 – land monitoring. Sentinel-2A launched in 2015/Sentinel-2B in 2017
- Sentinel-3 – ocean forecasting, environmental and climate monitoring. Sentinel-3A launched in 2016. Sentinel-3B in 2018
- Sentinel-4A – atmospheric monitoring payload (2021)
- Sentinel-5 – atmospheric monitoring payload (2021)
- Sentinel-5 Precursor – atmospheric monitoring launched in 2017
- Sentinel-6 – oceanography and climate studies (2020)

Galileo: ‘made in Europe’

- Galileo will provide a highly accurate, guaranteed global positioning service under civilian control
- Full Operational Capability – 22 satellites, with 26 now in orbit. Deployment of remaining ground/space infrastructure ongoing
- ESA is the system architect for Galileo, managing its design, development, procurement, deployment and validation on behalf of the EU. ESA will maintain this role, providing technical support to the European GNSS Agency, designated by the EC to run the system and provide Galileo services
- December 2016 – start of Galileo Initial Services, the first step towards full operational capability
- With the new ESA Navigation Innovation and Support Programme (NAVISP), research will focus on integration of space and terrestrial navigation and new ways to improve GNSS

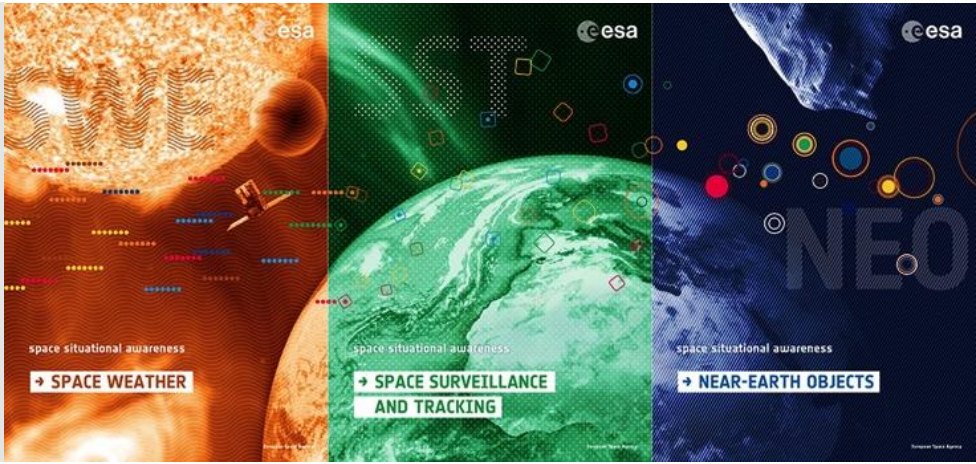


A pioneer in telecoms

- Europe started in 1968 to develop communications satellites. The Orbital Test Satellite 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
- ESA's Advanced Research in Telecommunications Systems (ARTES) programme stimulates innovation and promotes the development of products, services and applications in partnership with industry

Space Situational Awareness

ESOC is home to the Space Situational Awareness Programme (SSA) an initiative aiming to provide European autonomy in civil systems and services needed to protect satellites and Earth.

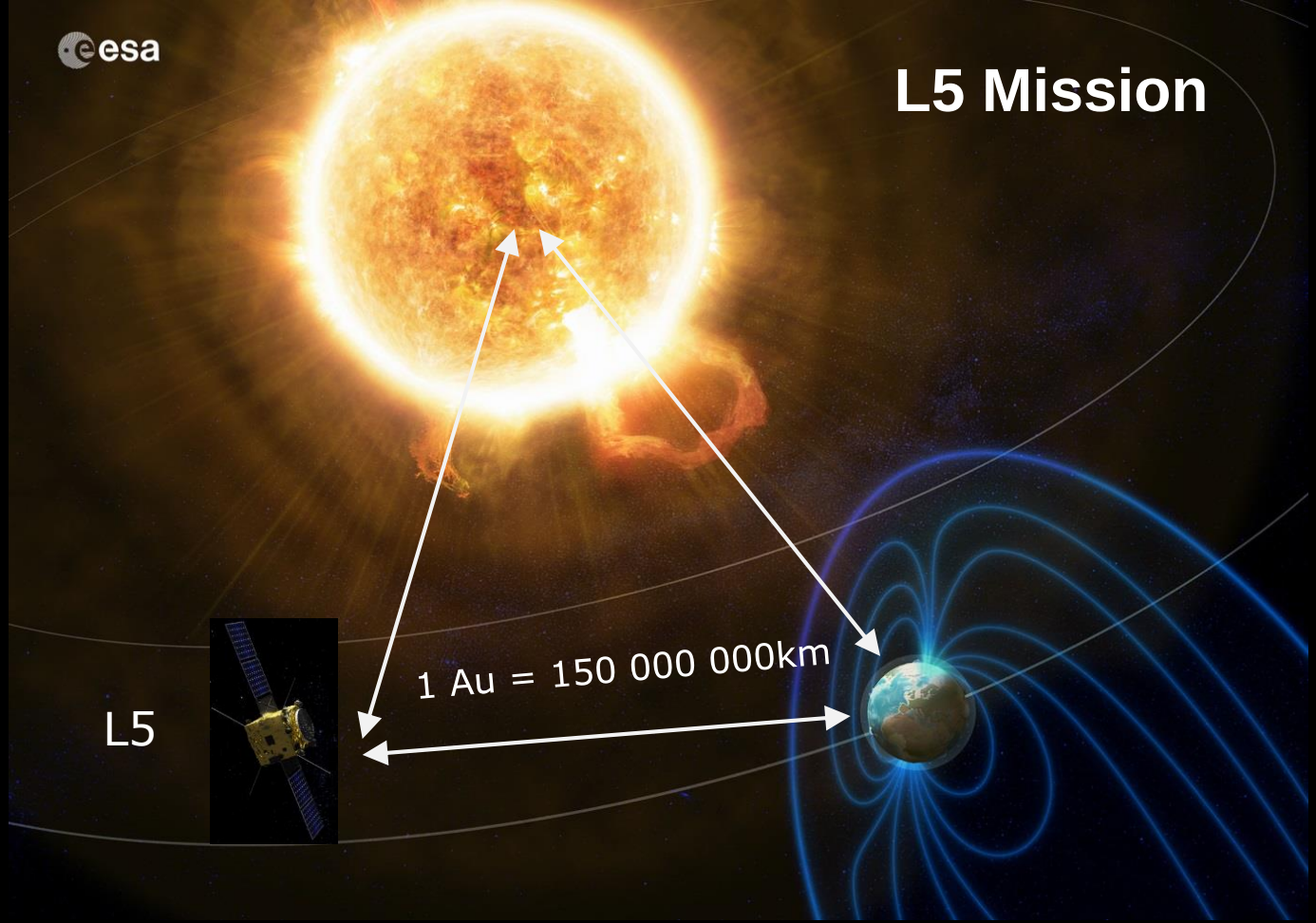


Entering its third development period, it will consolidate European facilities and services for:

- Monitoring, cataloguing and tracking space debris
- Monitoring space weather, and preparing for a future Lagrange mission
- Identifying and tracking near Earth objects

Supported by 19 Member States, SSA is coordinated with the institutions of the European Union and international partners

L5 Mission



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

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

Space Rider

- An affordable, reusable, end-to-end integrated transport system offering Europe independent access to and from low Earth orbit
- European opportunities for in-orbit validation of technologies
- First launch on Vega C in 2020

Future Launchers Preparatory Programme (FLPP)

1. Develop competitive technologies for future launchers that will:

- include low development and production costs, and lower risks
- shorten the launcher development phase to less than 5 years

New Economic Opportunities (NEO)

2. Invest in a more diversified launcher development portfolio focusing on:

- key technologies and new manufacturing processes;
- integrated demonstration before transfer into orbit;
- validating ultra-low cost engine demonstrator (Prometheus)

Mission operations

ESOC, the European Space Operations Centre, is ESA's centre for mission operations and ground systems engineering, where we:

- Study and develop mission concepts and technologies
- Specify required ground facilities and functionality
- Simulate mission scenarios and train multi-disciplinary mission teams
- Perform end-to-end mission readiness testing
- Plan and execute spacecraft and ground facilities operations during all mission phases

ESOC's ground systems engineering teams:

- Develop multi-mission infrastructure for mission control systems, ground stations, high-fidelity simulators, operational communication and computer systems and tailor them for specific missions
- Perform studies, mission analysis, flight dynamics, high-precision navigation, space-debris monitoring and avoidance and CleanSpace studies
- Develop new technologies and standards to support future missions

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

Space diplomacy - 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…

Cooperation between ESA and the EU

- Since 2004 the ESA/EU Framework Agreement is the basis for cooperation between ESA and the EU (extended until 2020)
- Article 189 of the Lisbon Treaty of 2009 gave mandate to the EU to develop a 'European' space policy, providing that it should establish appropriate relations with ESA
- ESA/EU ministerial-level meetings and related resolutions provide directions and guidelines for policy development
- ESA is implementing two flagship programmes for the EU: Galileo and Copernicus
- Horizon 2020 – ESA provides support to the EU in its implementation of space research and technology objectives
- Defence and Space – ongoing coordination between ESA, EC and EDA through different channels

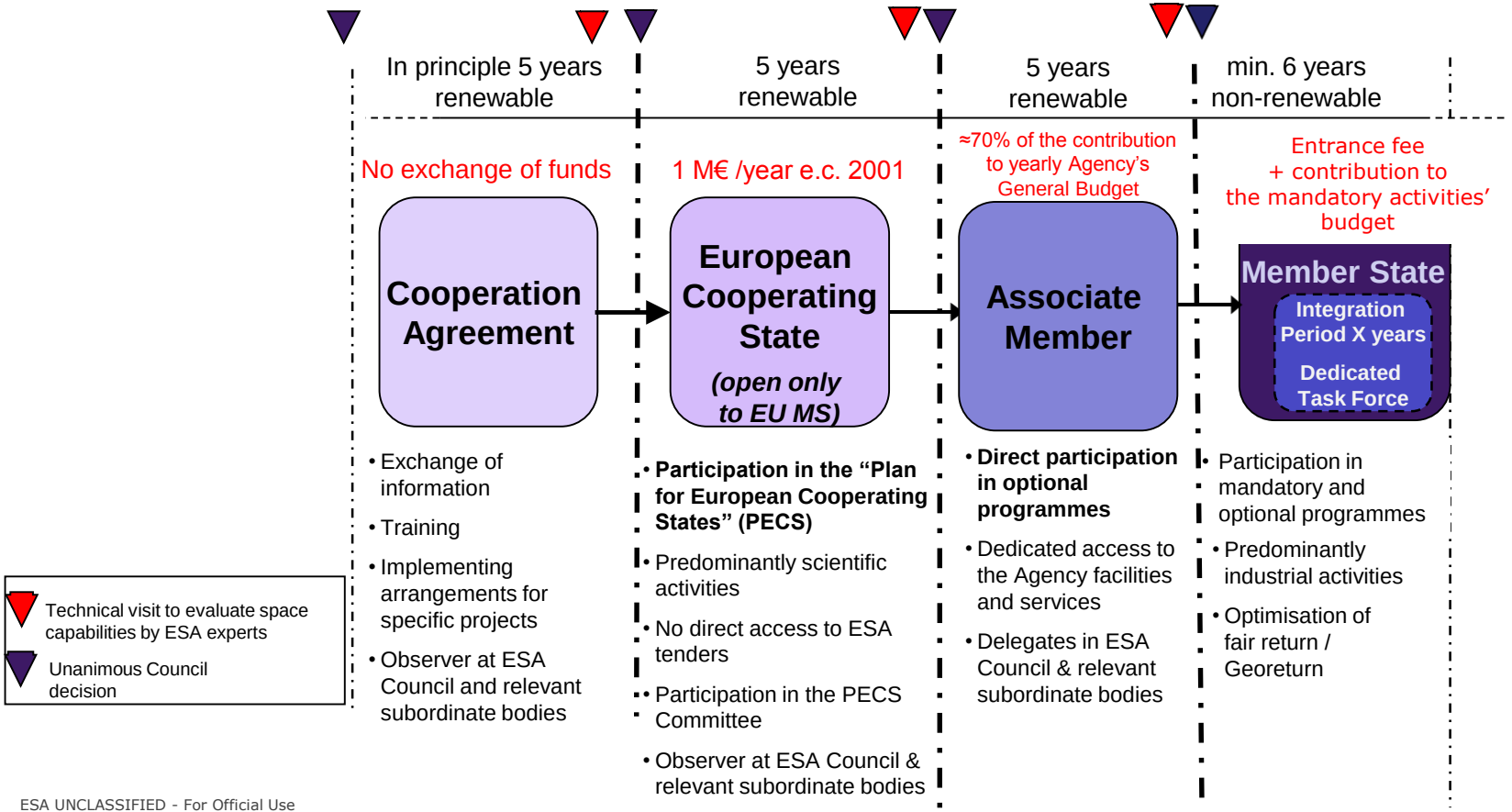
Formal cooperation with all EU Member States

- The Agency has now established formal cooperation with all Member States of the European Union that are not ESA members
- The ESA Convention provides for the different types of cooperation under its Article XIV
- Currently, the different types are: general Cooperation Agreement, the European Cooperating State (ECS) and Associate Membership
- Slovenia became an Associate Member in 2016, as Austria, Norway and Finland did prior to acceding to the Convention
- Since 2003, ESA has signed 11 European Cooperating States agreements. Currently, there are five countries with ECS status: Latvia, Lithuania, Slovakia, Bulgaria and Cyprus

ECS and PECS

- The definition of this new frame for cooperation dates back to 2001
- It then opened up opportunities for Czech Republic, Hungary, Poland and Romania, to be involved more closely with ESA programmes, procurements and activities
- The intention was to stimulate relations with interested European countries, to expand the overall European scientific and industrial base and to enrich ESA as a research and development organisation
- To be a candidate for an ECS agreement, a country must be European and already have signed a Cooperation Agreement with ESA, which is the case for Malta since 2012. The Cooperation Agreement with Croatia entered into force on 7 September 2018
- Such ECS Agreements provide a common basis and the appropriate operational arrangements for an efficient and mutually beneficial cooperation with regard to space activities for peaceful purposes, on a no-exchange-of-funds basis
- The participation is to be defined in a five-year Plan for European Cooperating State (PECS) to be jointly agreed. The PECS Committee, acting in coordination with ESA, monitors and controls the execution of the Plan
- This third-party funding scheme aims at increasing the national space competences and enabling ESA and the ECS to start working together on concrete activities

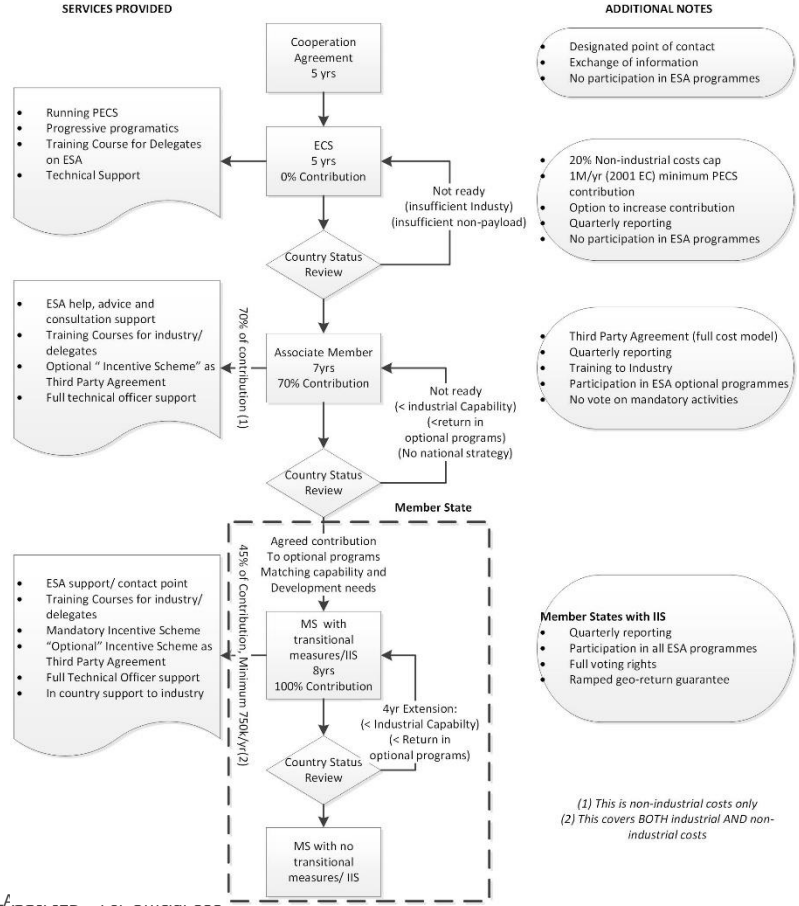
From Cooperation to Accession for EU Member States not members of ESA



Towards a coherent end-to-end integration process

- A proposed evolution of the end-to-end integration process, adopted by ESA Council in December 2018, will be presented to the next PECS committee in June 2019
- The objective of the proposal is to ensure a smooth integration of European State into ESA by strengthening capacity building to become reliable partners in the Agency
- The new measures, based on lessons learnt and the experiences gained, include:
  - reduction of time-to-contract
  - improved process governance
  - training (for delegations, for industry…)
  - country status review (thresholds)
  - clear non-industrial costs
  - minimum contribution
  - option to increase the funding at any time
  - extended duration of the steps etc.

Overview of ‘standard’ Accession Flow



ESA's contribution to European space policy

ESA's Resolution on Space 4.0 provides a way forward for the evolution of ESA as THE space agency for Europe

In December 2016, in Lucerne (Switzerland), ESA Member States adopted a 'Resolution on their Vision of a United Space in Europe in the era of Space 4.0'

Space 4.0 is adapted to an ESA-specific derivative, 'Space 4.0i', which describes the way ESA will play its role as a space agency for Europe

Space 4.0i combines the described global situation of space developments with the 'i' standing for an ESA-specific interpretation of the tasks:

- ESA innovates – through more disruptive and risk-taking technologies
- ESA informs – through the reinforcement of the link with large public and user communities
- ESA inspires – through the launch of new initiatives and programmes
- ESA interacts – through enhanced partnerships with Member States, European institutions and Academia, international players, industrial partners and new actors.

ESA and the European space sector

- Europe is successful in the commercial arena, with a large market share of telecom and launch services
- European scientific communities are world-class and is an active international cooperation partner
- Research and innovation centres are recognised worldwide
- European space operators (Arianespace, Eumetsat, Eutelsat) are among the most successful in the world
- The European space industry sustains around 35.000 direct jobs

NEXT STEP

SPACE19+

Safeguarding our planet for future generations - Space Safety and Security

- Improve space debris threat detection and risk analysis capability
- Improve space debris mitigation and protection

Planetary Defence - Space Safety and Security

- Improve asteroid hazard detection and risk analysis capability
- Improve asteroid impact protection

Space Weather - Space Safety and Security

- Implementing a European space weather monitoring system

Operations - Enabling and Support

- Continue fostering a strengthened European Network of Operations Centres to strategically manage European resources and expertise, boost European leadership, increase efficiency and effectiveness and drive innovation and industrial competitiveness
- Serve as ‘the’ European centre for innovation for spacecraft operations and foster industrial competiveness

Technology - Enabling and Support

- Substantial investment in skills and tools for technology and engineering R&D at ESA
- Technology Programme for higher-Technology Readiness Level technologies, which also offers small space missions to industry for early demonstration of their technologies

Space Transportation - Enabling and Support

Development:

- enhance the competitiveness of Ariane and Vega
- continue to develop our new reusable spaceship allowing operational capabilities of return to Earth: Space Rider

Exploitation:

- accompany European industry in the first phases of the exploitation of the new launchers Ariane 6 and Vega-C
- modernise Europe’s Spaceport in French Guiana

Future:

- prepare the next generation of launchers, starting with new and enhanced propulsion competences, to make launchers more efficient
- support the emergence of commercial space transportation services, such as micro-launchers

Science - Science and Exploration

- Continue to operate our fleet of missions that yield excellent science, including Gaia, and fly BepiColombo to Mercury
- Launch six already approved new missions: Cheops, Solar Orbiter, JWST, Euclid, Juice, and Plato
- Lead Ariel to adoption and implement several international Missions of Opportunity
- Prepare the M and the F missions for selection
- Jointly implement the flagship missions Athena and LISA
- Prepare the M* ice giant mission together with NASA
- Start the next strategic planning cycle following Cosmic Vision leading to 2050

Low Earth Orbit - Science and Exploration

Operation of the ISS to 2024 including multiple future astronaut missions

- A comprehensive programme of peer-reviewed, world-class science proposed by scientists across Europe
- A new action to stimulate commercial research and applications in low Earth orbit as part of the wider ESA 'Downstream Gateway'

Humans at the Moon - Science and Exploration

- Europe joining the international team building humankind's most distant outpost, the Lunar Gateway - a spaceport above the Moon; a basecamp for long-term lunar exploration; and a step on the road to Mars
- Working with international partners, start building key elements of the Lunar Gateway including a habitation module for the four crew; telecoms relay systems; an airlock for deploying scientific instruments and CubeSats into lunar orbit; as well as a European Service Module for Orion to shuttle the crew to the Gateway and back

Mars – Science and Exploration

- To maximise the science return from the ExoMars Trace Gas Orbiter, the largest science orbiter operating at Mars
- To complete and launch the ExoMars rover mission in cooperation with Russia, to explore below the surface of Mars for the first time in search of clues about whether life ever existed on Mars
- Based on a cooperation with NASA, to start building the Mars Sample Return Earth Return Orbiter and the Sample Fetch Rover for launch as early as 2026

Future of Telecom - Applications

- Integrating space assets into 5G preparations
- Invest in optical communications
- Enlarge secure communications portfolios

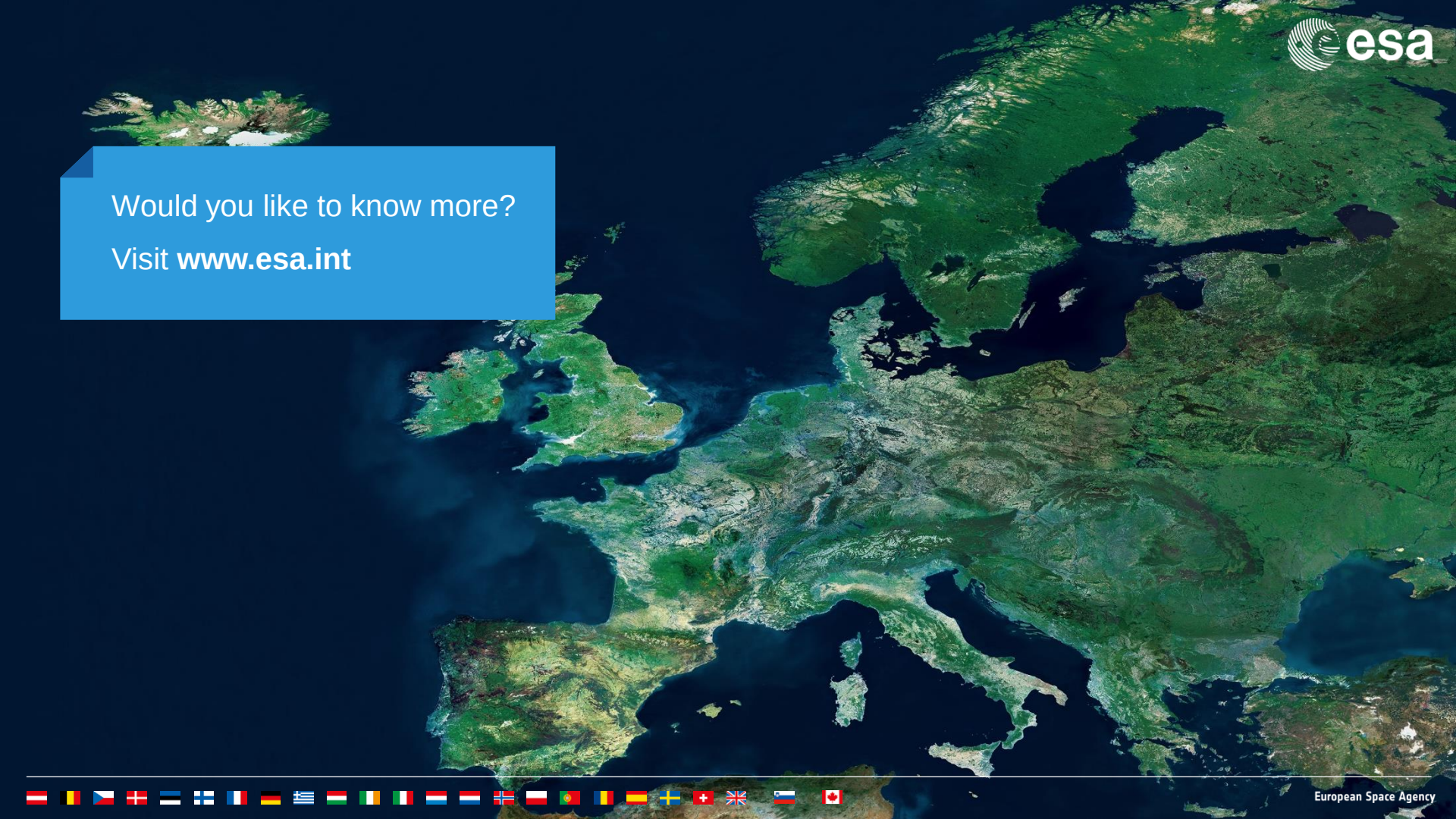
Future of Navigation – Applications

- Through the NAVISP programme, ESA is encouraging European Industry to research multiple initiatives, bolstering competitiveness in the growth area of Positioning, Navigation and Timing
- Maintain and improve the existing infrastructure to deliver high quality services of the EU's EGNOS and Galileo Programmes
- The design and development of the new generation of systems and the technical development of the infrastructure for Europe's navigation systems as part of our responsibility under existing agreements with EU

Future of Earth Observation

In order to continue European leadership in monitoring the state of our planet from space, to advance science and research in the understanding of the Earth system and to create business opportunities in a fast evolving geo-services sector, Earth Observation will focus on the following cornerstones, whilst also re-enforcing the need to establish an end-to-end system approach by optimising the ESA assets as a complement to those of Member States in order to develop a stronger and more coherent Earth observation capacity for Europe:

- Future EO dedicated to innovation, built on a user-driven innovation approach and the core R&D that prepares all future ESA Earth Observation activities
- Customised EO to support industry, services and national ambitions through new and ad hoc elements of Earth Watch
- Operational EO to support the development of operational programmes – ensuring the continued development of large-scale operational programmes with European partners. In particular, this comprises the development of the Copernicus space component together with the EU/EC and the preparation of meteorological programmes with EUMETSAT
- Safety and security EO, where these activities will be the EO contribution to a cross-directorate endeavour, namely the pillar "Safety and Security"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