ESA TECHNOLOGY PROGRAMMES AND STRATEGY

Czech Space Technology Day - GSTP
July 2010

European Space Agency
www.esa.int

CONTENTS

- The European Space Agency -ESA
- Space Technology
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- Doing business with ESA
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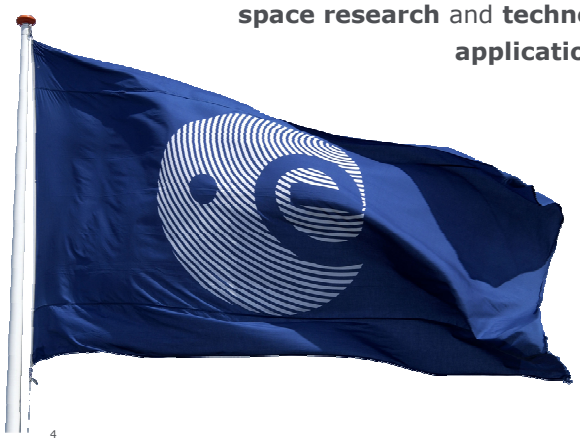
PURPOSE OF ESA

"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**

ESA FACTS AND FIGURES

- **Over 30 years of experience**
- **18 Member States**
- **Five establishments, about 2000 staff**
- **3.7 billion Euro budget (2010)**
- **Over 60 satellites designed, tested and operated in flight**
- **17 scientific satellites in operation**
- **Five types of launcher developed**
- **Over 190 launches**

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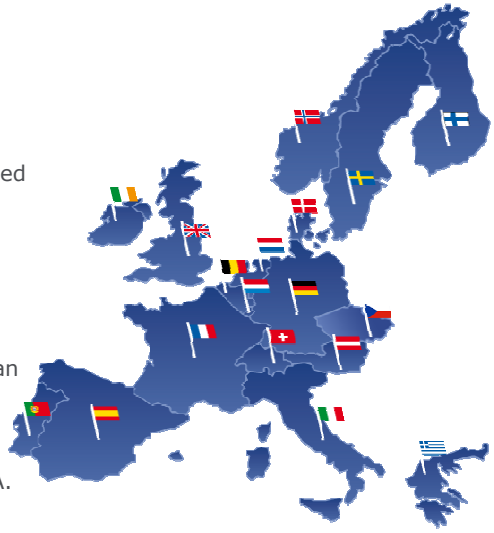
18 MEMBER STATES

Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Norway, the Netherlands, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Canada takes part in some programmes under a Cooperation Agreement.

Hungary, Romania, Poland, Slovenia, and Estonia are European Cooperating States.

Cyprus and Latvia have signed Cooperation Agreements with ESA.



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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**
- **Human spaceflight**
- **Exploration**
- **Earth observation**
- **Launchers**
- **Navigation**
- **Telecommunications**
- **Technology**
- **Operations**

ESA PROGRAMMES

All Member States participate (on a GNP basis) in activities related to space science and a common set of programmes (**Mandatory** programmes).

Mandatory

- General Budget: Future studies, technological research, education, common investments (facilities, laboratories, basic infrastructure)
- Science: Solar System science, astronomy and fundamental physics

In addition, Member States choose their level of participation in **Optional** programmes.

Optional

- Human Spaceflight
- Telecommunications & Integrated Applications
- Earth Observation
- Launchers
- Navigation
- Robotic Exploration
- Space Situational Awareness

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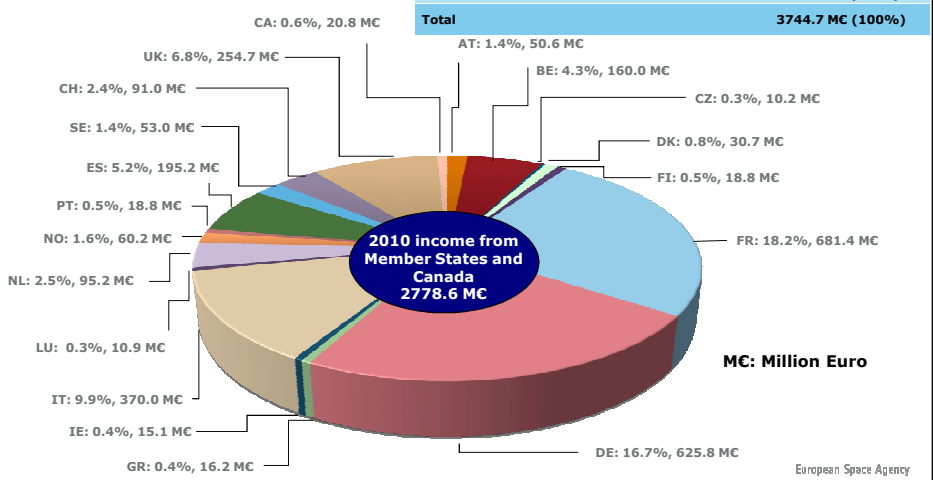
ESA BUDGET FOR 2010

Income from Member States and Canada	2778.6 M€ (74.2%)
Income from EU	754.8 M€ (20.2%)
Income from ECSA	5.2 M€ (0.1%)
Other income	206.1 M€ (5.5%)
Total	3744.7 M€ (100%)



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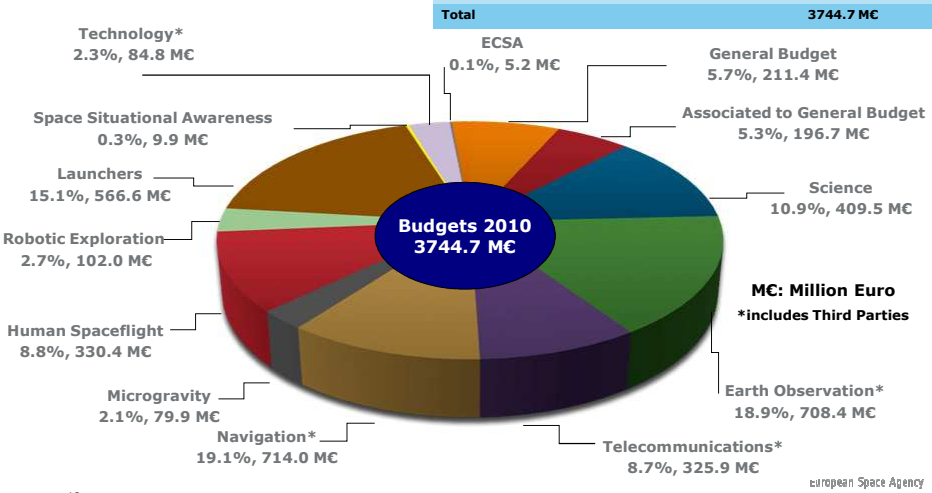
ESA BUDGET BY PROGRAMME (2010)

Programmes and mandatory activities	3739.5 M€
European Cooperating States Agreement (ECSA)	5.2 M€
Total	3744.7 M€



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ESA COUNCIL

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

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

The ESA Council at ministerial level also meets together with the EU Council to form the European 'Space Council'.

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ESA MINISTERIAL CONFERENCE 2008

- Significant emphasis on applications, meteorology, GMES, TEL, GNSS and IAP (Integrated Applications Programme)
- Strengthening of mandatory Space Science Programme and basic technical activities
- Exomars strong preparation for consolidation prior to final decision
- Consolidation of launchers and continue towards new launcher
- Preparatory activities for Robotic and Human Transportation and Exploration preparing for decision in 2011
- Start of SSA (Space Situation Awareness)
- **Strengthening of GSTP**

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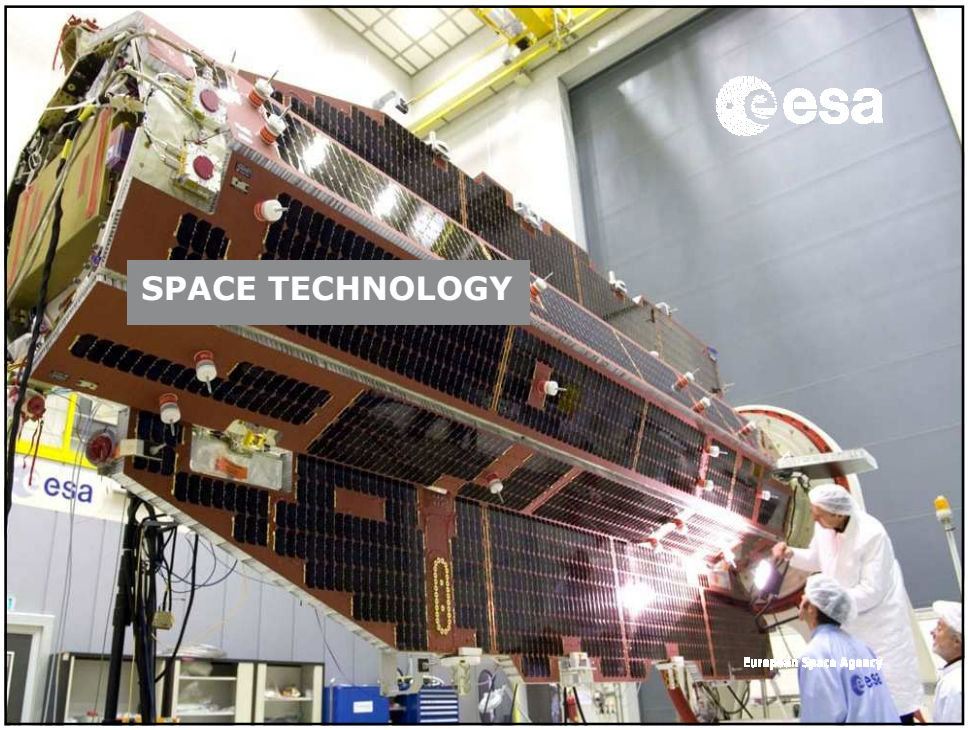

EUROPEAN SPACE POLICY

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.

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SPACE TECHNOLOGY

The development of technology, along with access to space, is one of the **enabling** activities of ESA.

• Supporting the **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 the design of new space systems ('**spin-in**').

• Fostering **innovation** and enhances European **technological non-dependence** and the availability of European resources for **critical technologies.**

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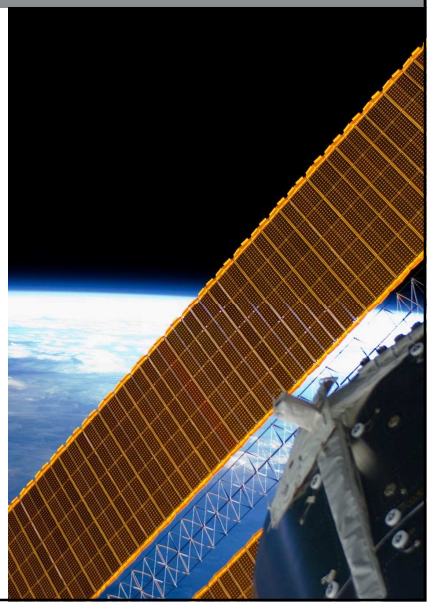
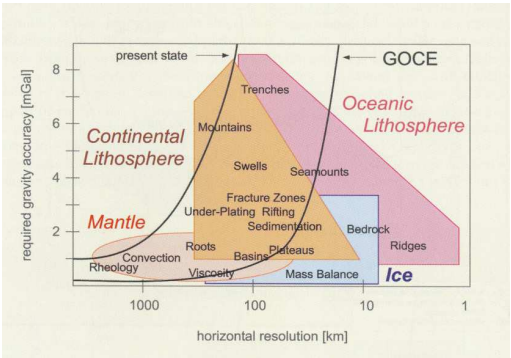


SPACE TECHNOLOGY – ENABLE FUTURE MISSIONS

Technology development allows developing missions with higher performance at lower cost.

GOCE provides better performance than its precursor concept Aristoteles at lower cost



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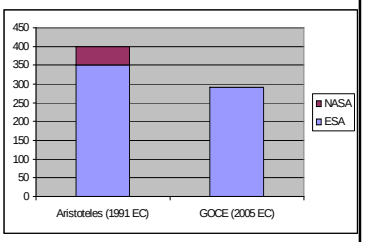

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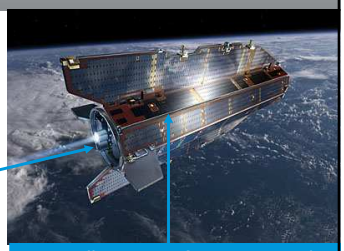
SPACE TECHNOLOGY – COMPETITIVENESS

- In the European market and in the global commercial market.
- Balance innovation – product development. Innovation is necessary, and not the only ingredient. Industry must have products, "accepted", used, resistant to obsolescence
- User drive. Surveys of and with industry, market analysis.
- Standardisation and modularity.
- The difficult part is to bridge the "death valley" from the innovative concept phase to the product development, i.e. to reach high TRL
- For both innovation and product acceptability there is a need to facilitate in-orbit demonstration
- It is necessary to support the complete "product cycle"

SPACE TECHNOLOGY – INNOVATION

- Research of, in and from space and sustainable service driven missions continuously require new solutions;
- Competition implies being better when not cheaper
- Innovation is essential part of the solution
- ESA missions are technology innovation drivers
- Innovation happens in many ways:
  - Concepts and basic technology
  - Components, (e.g. AGGA in GNSS receiver)
  - Products, (e.g. gradiometer, ion thrusters for drag compensation



Intelligent configuration and design, small cross section, total symmetry, no moving parts

Continuous drag compensation made possible by new use of ion thrusters

SPACE TECHNOLOGY – INNOVATION, HOW

- **Strawman target setting**, how could be do a known mission for a fraction of resources, e.g. Marx Express
- **Forward-looking**: what would be the impact of new technology, e.g. wireless, new propulsion, etc; also from non-space: spin-in
- **Fast transfer of knowledge and technology**:
  - Academia – ESA: Networking Partnering Initiative (NPI)
  - ITI (Innovation triangle Initiative), in the Technology Research Programme
  - Fast concurrent transfer and prototyping of technology: Startiger, concurrent prototyping
- Special "**techno-push**" in Technology Research Programme
- **Permanent Announcement of Opportunities** mechanisms, specially GSTP AO
- Support to **complete development cycle** up to demonstration
- **Cooperation** new partners, European Networks, participation in non-space areas

SPACE TECHNOLOGY – SPIN-IN AND SPIN-OFF

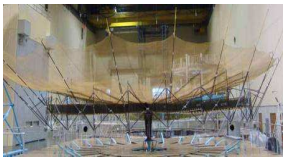
- Transferring technology from space to non-space applications ('**spin-off**'), and bringing innovations from outside the space sector to use in the design of new space systems ('**spin-in**').

Considerations:

- Breakthrough in space technology (–not mission related-) limited, due to funding and conservatism in terms of engineering
- In many domains, technology advances faster for terrestrial applications than for space, requiring systematic spin-in
- Find the convergence between the terrestrial developments and the achievable technology breakthrough for space
- Space technology has features attractive for demanding terrestrial applications
- Common interest with related sectors, aeronautics, automotive, ICT, etc

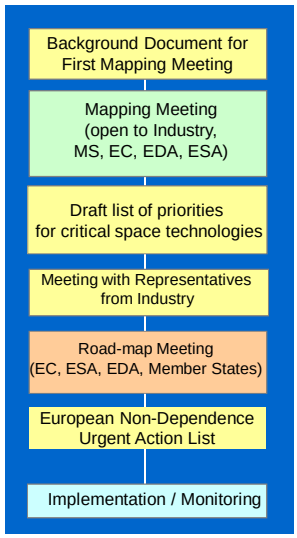
WHAT IS "NON-DEPENDENCE"

- **Technology "non-dependence"** means assured (non-dependent) access to any technology required to implement Europe's space missions
- Non-dependence does not mean producing everything in house
- It is not just an ITAR problem, non-export restricted products come with limitations that create undesirable dependence
- It is not only an issue for EEE parts, but affects other products
- It is not an issue of end products only but affects all capabilities in the complete supply chain



THE EUROPEAN NON-DEPENDENCE PROCESS

- In 2009, EC-EDA and ESA have set up with its member states and industry a process for the identification of critical technologies for urgent action
- The ESA Technology Harmonisation Advisory Group (THAG) was expanded to EC and EDA and their national delegates, for Non-Dependence issues
- The first mapping meeting took place in September 2009 and the final roadmap meeting in December 2009
- It resulted in the common European Non-Dependence Urgent Action List (2010/2011)
- The process has a 2 year revisit cycle (next cycle 2011), with monitoring on a more regular basis
- The institutions are to make best use of the available instruments for implementation until more dedicated programmatic instruments are set up



TECHNOLOGY PROGRAMMES

esa

Mandatory Programmes

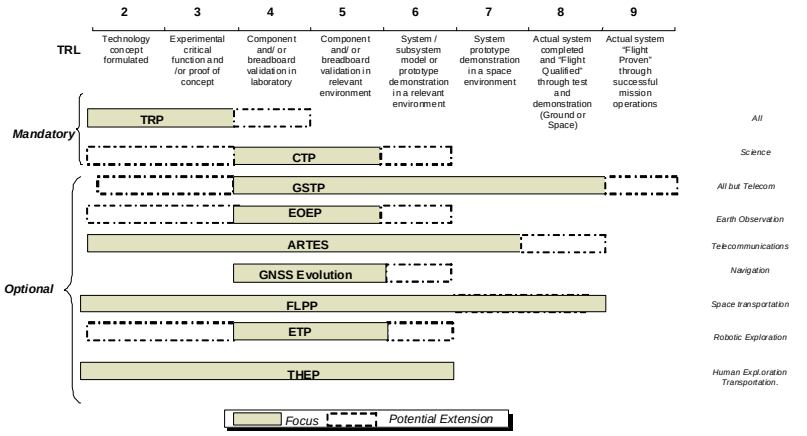
- Science Core Technology Programme (CTP),
- **Basic Technology Research Programme (TRP)**

Optional Programmes

- **General Support Technology Programme (GSTP)**
- Earth Observation Envelope Programme (EOEP)
- Advanced Research in Telecommunication Systems (ARTES 3-4, 5)
- European GNSS Evolution Programme (EGEP)
- Future Launchers Preparatory Programme (FLPP)
- Transportation and Human Exploration Preparation (THEP)
- Robotic Exploration (ETP)

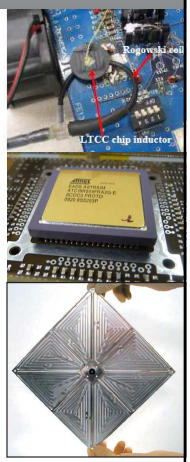
PROGRAMME IMPLEMENTATION

Technology Programmes versus Technology Readiness Levels



TECHONOLOGY RESEARCH PROGRAME (TRP) OVERVIEW

- Part of ESA's Mandatory Programmes.
- Main support of technology innovation and basic technology research
- All Member States participate (on a GNP basis)
- Covering all technology disciplines and applications. Includes Generic Domain for common needs and technology push.
- Three-years Workplans, with yearly updates, and multiyear activities.
- Budget envelop year ~ 50 Meuro



TRP demonstrates the workability of a given technology long before a mission is based around it

SCIENCE CORE TECHNOLOGY PROGRAMME (CTP) OVERVIEW

- Part of ESA's Mandatory Programmes.
- All Member States participate (on a GNP basis)
- Three-years Workplans, with yearly updates, and multiyear activities.
- Yearly budget ~ 11 Meuro

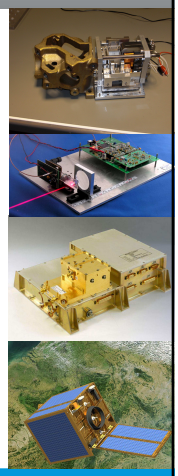
LISA Pathfinder propulsion module

- CTP activity carries science mission technologies to higher stages of technological maturity, up to full-scale engineering models fully tested in relevant environmental conditions
- Close coordination with TRP - Technologies are brought to the proof-of-concept stage through the TRP then transferred to the CTP to reach the engineering model stage.

Ensure early and effective preparation of ESA's future science missions by advance development of the critical technologies needed to make them happen.

GENERAL SUPPORT TECHNOLOGY PROGRAMME (GSTP) - OVERVIEW

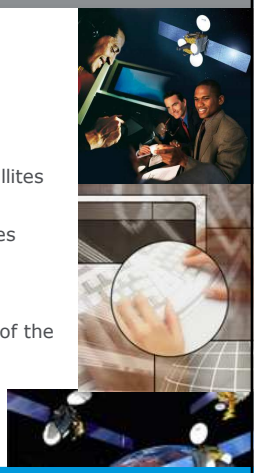
- Part of ESA's Optional Programmes.
- Voluntary participation of all Member States (including Canada as associate Member State)
- Covering all technology disciplines and applications except Telecommunications (covered by the ARTES programmes).
- Five-years Workplans, with yearly updates, and multiyear activities.
- Aims at maturing technology and develop products.
- Budget envelop five year ~ 350 Meuro



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

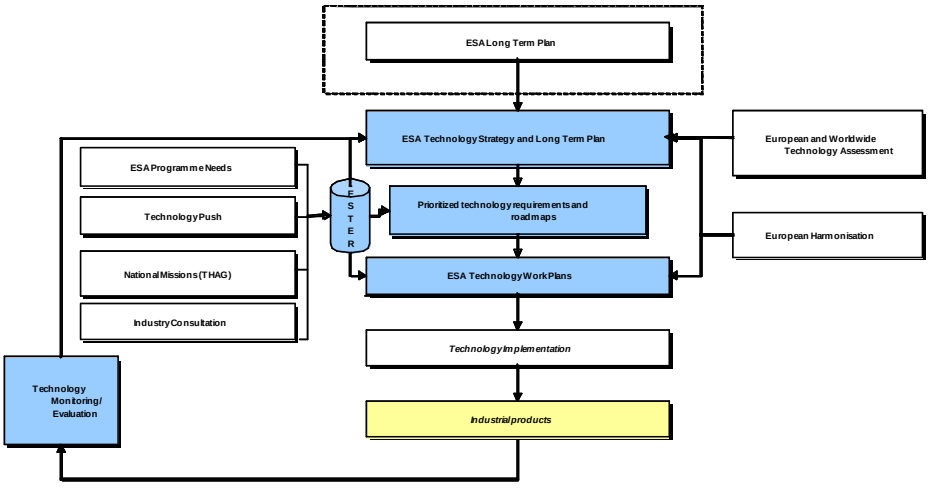
ADVANCE RESEARCH IN TELECOMUNICATION SYSTEMS (ARTES) OVERVIEW

- Part of ESA's Optional Programmes.
- Voluntary participation of all Member States (including Canada as associate Member State)
- ESA's Telecommunications programme seeks to enhance the competitiveness of European industry by promoting the use of satellites in such functions as broadcasting, multimedia and mobile communications, data relay, search and rescue and aviation services
- ESA Telecommunications' technology R&D activities are mainly organised through ARTES 3-4 and 5.
  - **ARTES 3-4** seeks to improve the near-term competitiveness of the satcom industry by developing near-to-market products.
  - **ARTES 5** seeks to develop a more sustained long-term technological basis for European industrial effectiveness,



The ARTES 3-4 and 5 programme greatly contributed to the competitiveness of the European Telecoms Industry

END-TO-END ESA TECHNOLOGY MANAGEMENT PROCESS



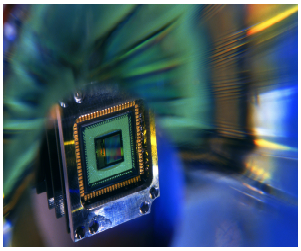
SPACE TECHNOLOGY HARMONISATION

The European Harmonisation process:

- Implemented since 2000, it provides to all European actors the framework and the key instruments to coordinate Space Technology at European level
- More than 50 technologies harmonised
- Active participation of all Delegations, more than 1000 Professionals from more than 200 entities

Main objectives

- "Fill strategic gaps" and "Minimize unnecessary duplications"
- Consolidate European Strategic capabilities
- Achieve a coordinated and committed European Space Technology Policy and Planning
- Ensure continuity and coherence between Technology and Industrial Policies



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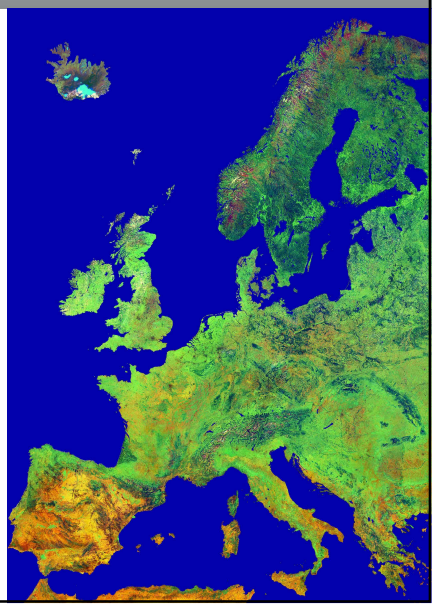
SPACE FOR EUROPE

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 will bring substantial benefits to Europe by:

• guaranteeing Europe's full and unrestricted access to services provided by space systems for its policies, and

• encouraging the increasing use of space to improve the lives of its citizens.



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EU-EC COOPERATION ON SPACE TECHNOLOGY

- Mid-2001 to mid-2004, coordination of technology R&D activities took place through the Working Group on Technology (WGT) of the EC/ESA Joint Task Force (JTF).
- **In May 2004**, the entry into force of the **EC/ESA framework agreement of cooperation**, led to the creation of a more permanent structure of collaboration, the Joint Secretariat (JS).
- **In May 2007**, the 4th Space Council welcomed and supported the document on the **European Space Policy (ESP).** The document states "The ESA-led process of harmonising technology development programmes provides transparency on research across Europe and paves the way for improved coordination."
- In May 2007, an agreement was reached that ESA should not be a participant to the EC-FP7 Space SSF Call, but instead support the EC in FP7-Space workprogramme preparation, proposal evaluation and monitoring of the selected projects.

ESA INTERACTION WITH EC ON FP7 THEMES

- Health;
- Food, Agriculture and Biotechnology;
- Information and Communication Technologies (ICT);
- Nanosciences, Nanotechnologies, Materials and new Production Technologies (NMP);
- Energy;
- Environment (including Climate Change);
- Transport (including Aeronautics);
- Socio-economic Sciences and the Humanities;
- Security;

ESA is partner e.g. in projects like LAPCAT II or Future High-Altitude High-Speed Transport (FAST) 20XX.

- **Space.**

ESA has special relationship on FP7-Space and will **not** participate to proposals

DOING BUSINESS WITH ESA

European Space Agency

EMITS

- EMITS is ESA's web-based system for publishing (competitive) Invitation-to-Tenders (ITT). It includes:
  - A list of intended ITTs: potential bidders may declare their interest and see which other companies have done the same
  - Many technical, administrative and contractual standards and documents (General Tender Conditions, General Clauses and Conditions for ESA Contracts, PSS-A forms, engineering standards etc)
  - Competitive ITTs
  - Competitive ITTs published by ESA on behalf of other entities
  - Request for Quotation (RFQs) is the term used for direct negotiations

http://emits.esa.int

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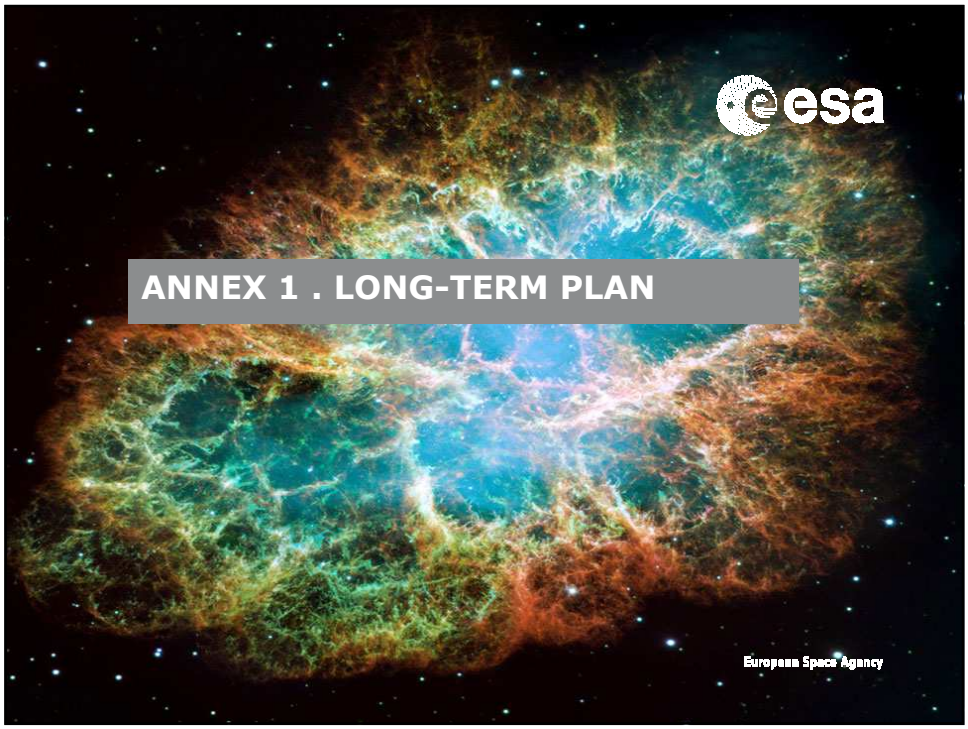
USING EMITS

- Review EMITS ITTs regularly
- Communicate your interest, via EMITS, to participate in the corresponding ITTs
- Contact potential partners identified via EMITS
- Respond to Invitations to Tender announced via EMITS
- Acquire and maintain an up-to-date knowledge of ESA's programmes, activities, organisation and methods of operation
- Pay special attention to the special clauses C1-C4 and also to announcements made on EMITS under "Entities"
  - C1: Activities reserved to Non-LSI and SMEs
  - C2: Activities subject to subcontracting Clause in favour of non-LSI and SMEs
  - C3: Activities restricted to SMEs and R&D Organisations
  - C4: Activities with Sub-contracting clause to SMEs only

Remember: award of ESA contracts require high quality proposals.
To learn: request a briefing following an unsuccessful proposal.



EARTH OBSERVATION EARTH EXPLORERS

Part of ESA's '**Living Planet' Programme**, these missions address critical and specific issues raised by the science community, while demonstrating the latest observing techniques.

GOCE (2009–) studying Earth's gravity field

SMOS (2009–) studying Earth's water cycle

CryoSat-2 (2010–) studying Earth's ice cover

The next missions are:

ADM-Aeolus – studying the atmosphere

Swarm – three satellites to study Earth's magnetic field

EarthCARE – an ESA/JAXA mission to study Earth's clouds, aerosols and radiation

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EARTH OBSERVATION EARTH EXPLORERS

Biomas: P-band sounding / imaging radar: very large aperture antenna, on-board processing, retrieval algorithms, attitude control

CoreH2O: Dual-frequency (X + Ku) SAR antenna technology, Ku-band RF EIK-TWT, snow pack retrieval algorithms

Premier: Sub-mm wave receiver, large aperture, ultra stable, pushbroom antenna, high spectral resolution FTS

Phase A
Selection

Explorer - 7

Call, Phase A Selection

EEx 8: Opportunity Mission

Explorer -8

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EARTH OBSERVATION METEOROLOGICAL MISSIONS

'Living Planet' also includes the next generation of missions dedicated to weather and climate.

Meteosat Third Generation – taking over from Meteosat 11 in 2015, the last of four Meteosat Second Generation (MSG) satellites. MSG is a joint project between ESA and Eumetsat.

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

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

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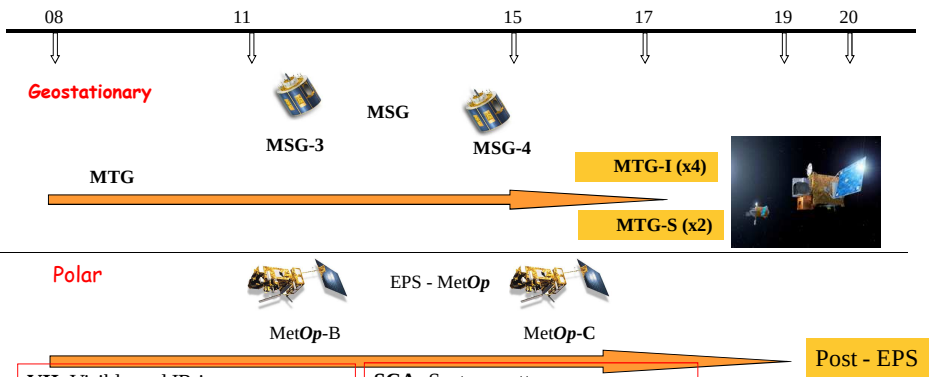
EARTH OBSERVATION METEOROLOGICAL MISSIONS



VII: Visible and IR imager
LLI: Low light imager
IRS: Infrared sounder
MWS: Microwave sounder
3 MI: multiview, channel pol.imager
Sentinel 5 – UVNS
RO: GNSS RO sensor
RER: Radiant energy radiometer

SCA: Scaterometter
MWI-P: mw precipitation imager
MWI-C: mw cloud imager
RO: GNSS RO sensor

DCS: Data Collection System
SEM: Space environment monitor
S&R: Search and Rescue

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EARTH OBSERVATION
OBSERVING OUR PLANET
FOR A SAFER WORLD

A joint ESA/European Commission initiative, **Global Monitoring for the Environment and Security (GMES)** is the response 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.

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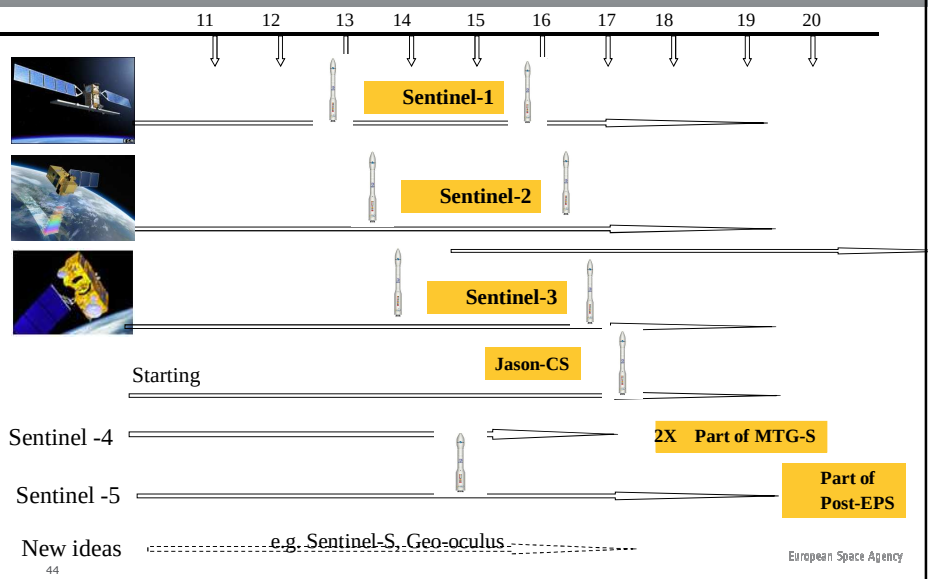
EARTH OBSERVATION
OBSERVING OUR PLANET
FOR A SAFER WORLD



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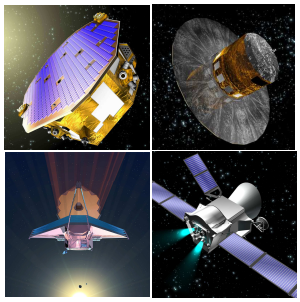
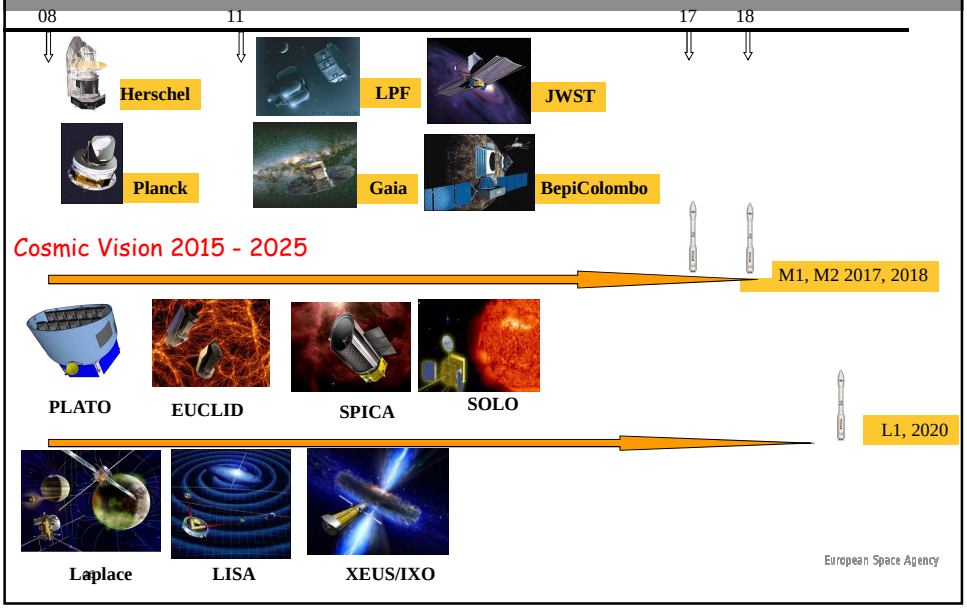
SCIENCE - UPCOMING MISSIONS

- **LISA Pathfinder** – testing technologies for gravity wave detection (2012)
- **Gaia** – mapping a thousand million stars in our galaxy (2012)
- **James Webb Space Telescope** – studying the very distant Universe (2014)
- **BepiColombo** – a satellite duo exploring Mercury (2014)



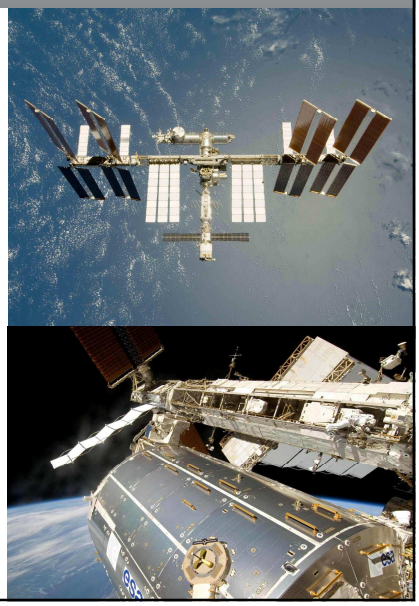
SCIENCE - UPCOMING MISSIONS



HUMAN SPACE FLIGHT
INTERNATIONAL SPACE STATION (ISS)

The ISS unites USA, Russia, Japan, Canada and Europe in one of the largest partnerships in the history of science. It provides a platform where 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 the **Cupola** and **Nodes 2** and **3**.



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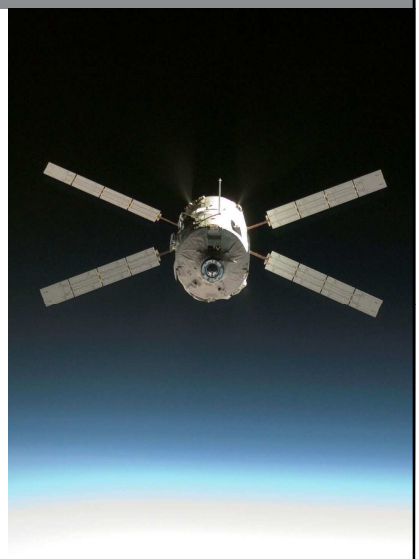
HUMAN SPACE FLIGHT
AUTOMATED TRANSFER VEHICLE (ATV)

ATV is an autonomous spacecraft for resupplying and reboosting the ISS. Each ATV carries up to 7.7 tonnes of cargo and fuel to the ISS. They then carry waste away from the ISS and burn up in the atmosphere in a controlled manner.

The first ATV, ***Jules Verne***, was launched in 2008. The second ATV, ***Johannes Kepler***, is being produced and another three ATVs are planned, for a launch every 17 months.

Building on ATV, the **Advanced Reentry Vehicle** (ARV) is being studied as part of ESA's European Transportation and Human Exploration Preparatory Activities.



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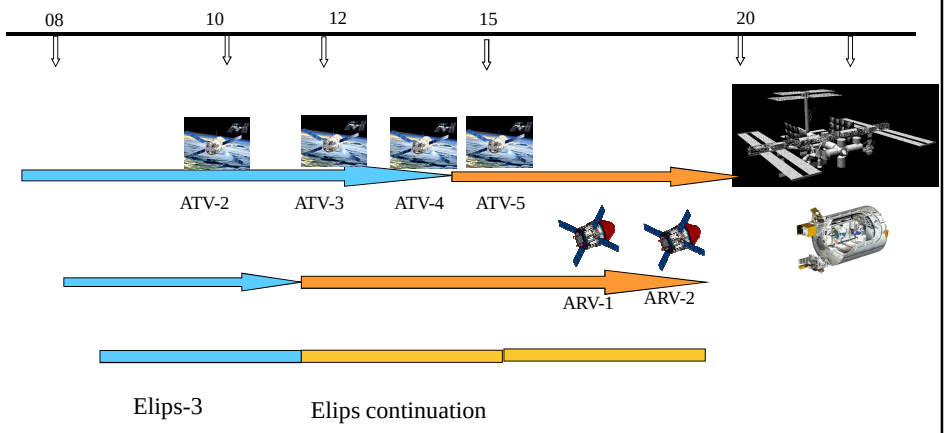
HUMAN SPACE FLIGHT



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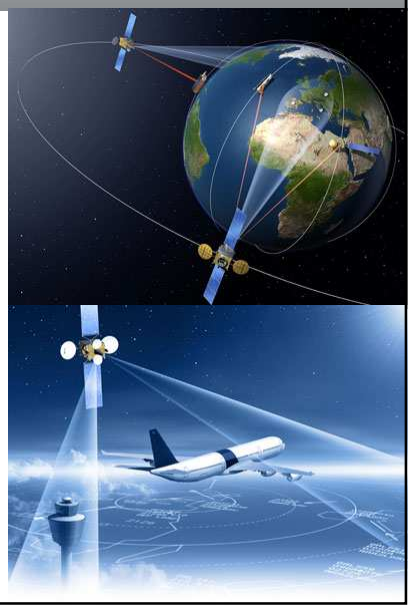
European Space Agency

TELECOMUNICATIONS NEW TELECOM PROGRAMMES AND INTEGRATED APPLICATIONS

EDRS – the European Data Relay Satellite system, planned for 2012. An independent European system to reduce time delays in transmission of large data quantities, making on-demand data available at the right place, at the right time.

Iris – developing a new air-to-ground communications system for air traffic management, the satellite-based solution for the Single European Sky ATM Research (SESAR) programme.

Integrated Applications Promotion - bringing together diverse space infrastructures to facilitate innovative solutions, leading to sustainable services.



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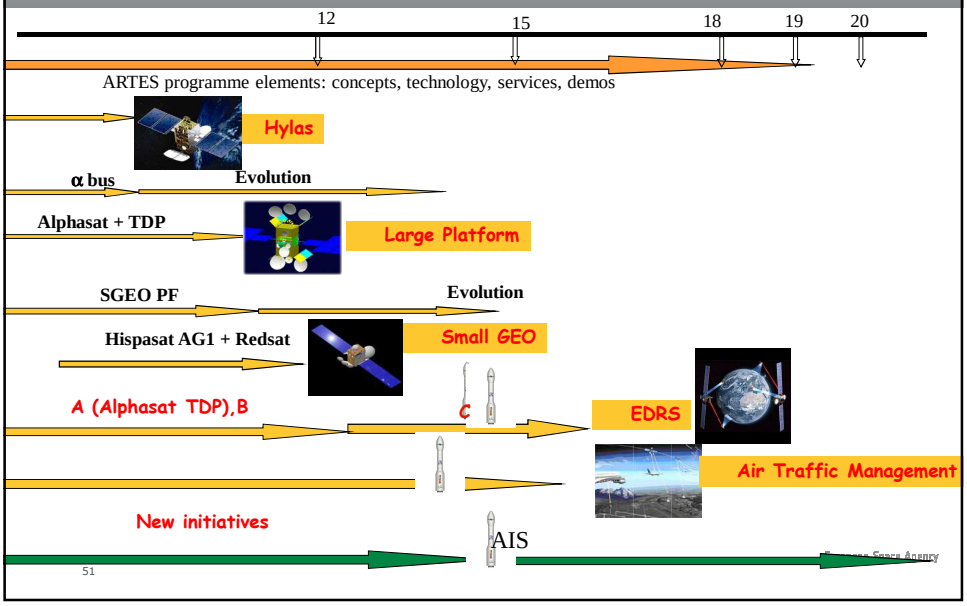
TELECOMUNICATIONS



SATELLITE NAVIGATION – GALILEO

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 Commission.

GIOVE-A - first Galileo test satellite, 2005

GIOVE-B - launched in 2008, successfully validated the technologies

Galileo IOV - first In-orbit Validation satellites due in 2011

FOC - Full Operational Capability satellites, expected 2012

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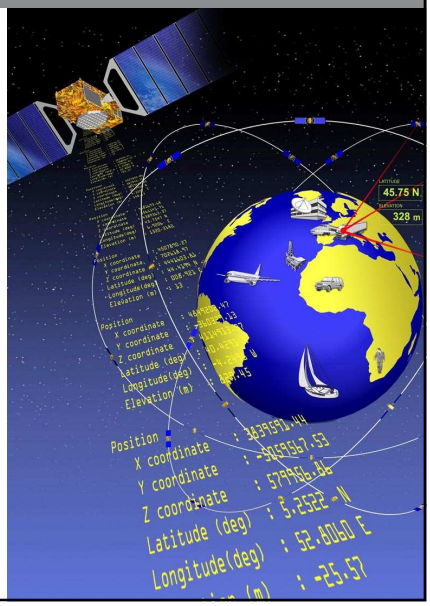
SATELLITE NAVIGATION – EGNOS AND GALILEO APPLICATIONS

EGNOS is a precursor to Galileo that augments GPS and GLONASS, making them suitable for safety-critical applications, such as aviation.

Galileo is expected to spawn a wide range of useful applications, including value-added services for transport by road, rail, air and sea, infrastructure and public works management, agricultural and livestock management and tracking, even e-banking and e-commerce authentication.

Galileo will be a key asset for the provision of public services, such as rescue operations, law enforcement and crisis management.



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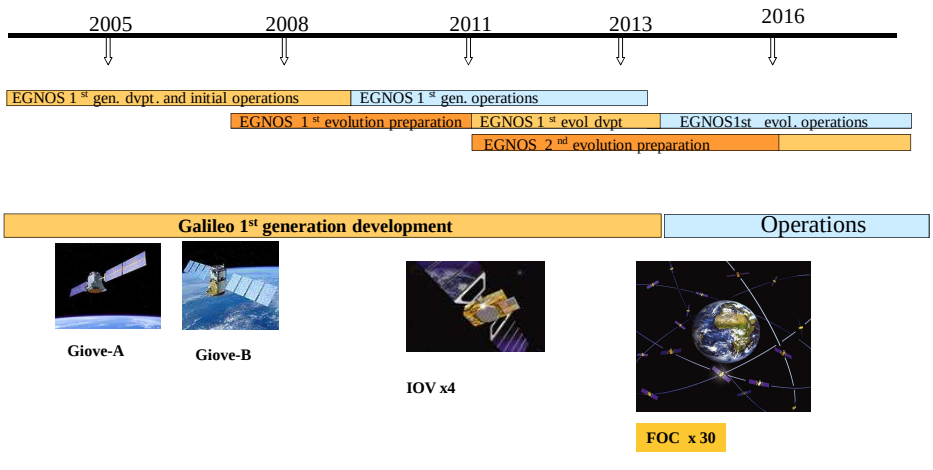
SATELLITE NAVIGATION



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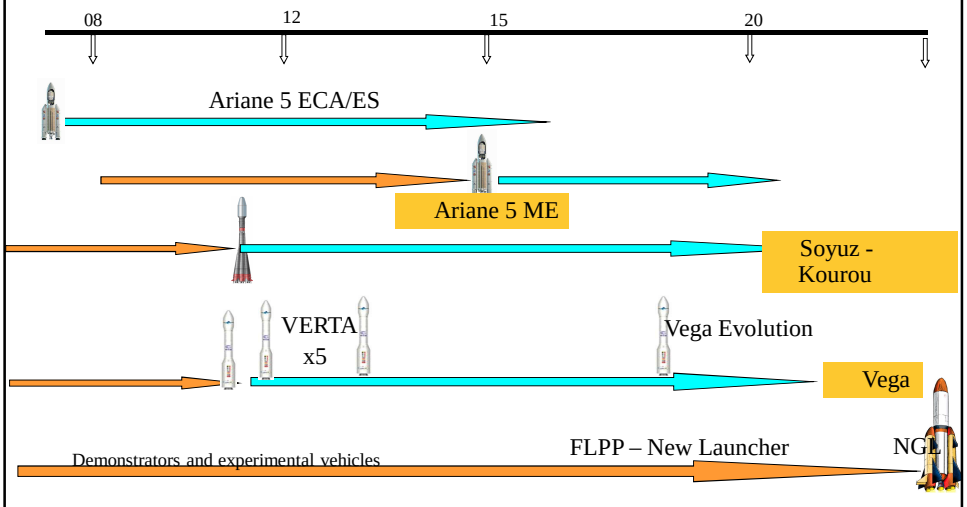
THE EUROPEAN LAUNCHER FAMILY

The launchers developed by ESA guarantee European access to space. Their development 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, soon to be complemented by **Vega** and **Soyuz**, launched from the European Spaceport in French Guiana.

LAUNCHERS



ROBOTIC EXPLORATION

ExoMars 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 in the 2020s.

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SPACE SITUATIONAL AWARENESS

The **Space Situational Awareness (SSA)** initiative aims to provide Europe and its citizens with accurate information about objects orbiting Earth, the space environment and threats, such as asteroids.

The initiative supports the autonomous capacity of Europe to securely and safely operate its critical space infrastructures.

The SSA system will also tell us more about 'space weather' (solar activity affecting satellites and ground infrastructure). It will identify and assess asteroids and comets, known as Near-Earth Objects (NEOs), that pose a potential risk of collision with Earth.

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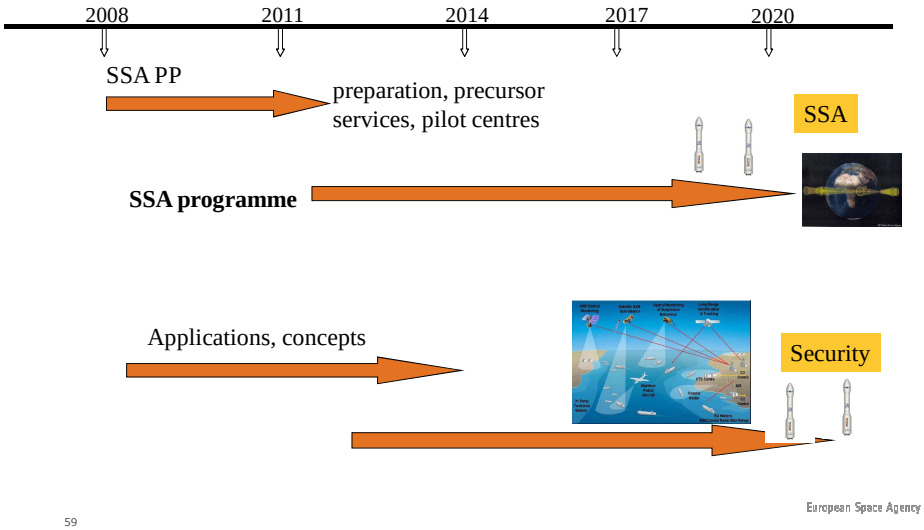
SPACE SITUATIONAL AWARENESS



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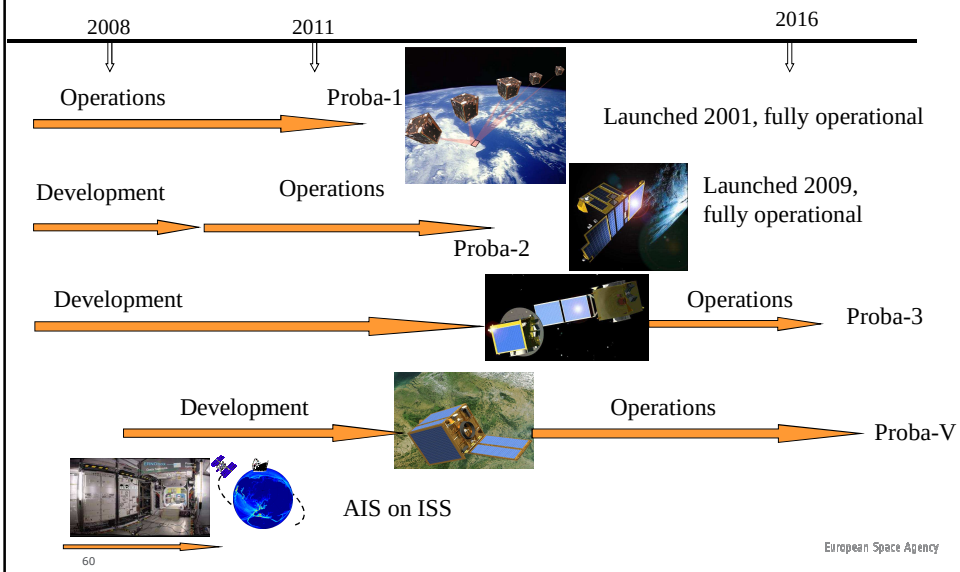
IN-ORBIT DEMONSTRATION



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