Europe and Space: the European Space Agency (ESA)

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Sofia, 13 January 2011
• (Why) Space

• ESA

• ESA and Europe

• ESA cooperation with EU Member States
• **Space as inspiration**: education, outreach
• **Space as innovation** + strategic significance
• **Space part of daily life**:
  - weather forecasting
  - air traffic control
  - communications and broadcasting
  - disasters (prevention and relief), etc.
• **Space as tool for challenges of 21\textsuperscript{st} century**:
  - environmental monitoring
  - management of natural resources
  - security and safety, etc.
• “**Space : a key asset for Europe to meet global challenges**”
• **Space as an economic driver**
The European Space Agency (ESA)

Convention signed in 1975, entry into force 1980
• ESA was formed in 1975 as a successor to ELDO and ESRO.

• ESA has today eighteen 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.


• Two candidate Member States:
  Hungary, Romania

• Relations with other EU Member States

• Canada
“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 is one of the few space agencies in the world to combine responsibility in all areas of space activity.
COUNCIL

- SCIENCE PROGRAMME COMMITTEE (SPC)
- ADMINISTRATIVE & FINANCE COMMITTEE (AFC)
- INDUSTRIAL POLICY COMMITTEE (IPC)
- INTERNATIONAL RELATIONS COMMITTEE (IRC)
- SECURITY COMMITTEE (SEC)
- SPACE SITUATIONAL AWARENESS COMMITTEE (SSA)

PROGRAMME BOARDS
- COMMUNICATIONS
- EARTH OBSERVATION
- LAUNCHERS
- HUMAN SPACEFLIGHT, MICROGRAVITY AND EXPLORATION
- NAVIGATION

DIRECTOR GENERAL
All Member States participate (on a GNP basis) in activities related to Space Science and in a common set of programmes (Mandatory programmes).

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

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

**Optional**
- Human spaceflight
- Telecommunications
- Earth observation
- Launchers
- Navigation
- Robotic exploration
ESA Budget 2010 – almost 90% return to European Industry

Income

- Income from member states and Canada: 2778.6 M€ (74.2%)
- Income from projects with EU: 754.8 M€ (20.2%)
- Income from cooperating members: 5.2 M€ (0.1%)
- Other income: 206.1 M€ (5.5%)
- Total: 3744.7 M€ (100%)

Expenditure

- Earth Observation: 684 M€ (18.3%)
- Launchers: 662 M€ (17.7%)
- Science: 610 M€ (16.3%)
- Human Spaceflight: 427 M€ (11.4%)
- Telecom: 358 M€ (9.6%)
- Navigation: 148 M€ (3.9%)
- Technology: 108 M€ (2.9%)

89% of the ESA Budget is returned to European industry - Mainly for research and development.
About 90% of ESA's budget is spent on contracts with European industry.

Industrial policy objectives:

– maintain and develop space technology,

– improve the worldwide competitiveness of European industry,

– encourage the development of an industrial structure appropriate to market requirements, making use of existing industrial potential of all Member States,

– ensure that all Member States participate in an equitable manner corresponding to their financial contribution.
Europe as a global space player

• Increased role for space in support of Europe
• Strategic importance of space for Europe to achieve its goals, both in Europe and in the world
• 2 EU flagship programmes: Galileo and GMES
• The need for a European Space Policy
• Stronger cooperation between ESA, the EU and the Member States
• Commitment by 29 countries
• ESA as a partner
EU and ESA


• On 22 May 2007, 29 Ministers (of ESA and EU) endorsed a European Space Policy, which had been prepared by the EC and the DG of ESA.

• Policy allows EU, ESA and their member States to increase coordination of their activities and programmes, and organise their respective roles relating to space, providing a more flexible framework to facilitate European investment in space activities.
Article 4

1. The Union shall share competence with the Member States where the Treaties confer on it a competence which does not relate to the areas referred to in Articles 3 and 6.
   • [. . . ].

3. In the areas of research, technological development and space, the Union shall have competence to carry out activities, in particular to define and implement programmes; however, the exercise of that competence shall not result in Member States being prevented from exercising theirs.
   • [...]
CONSOLIDATED VERSION OF THE TREATY ON THE FUNCTIONING OF THE EUROPEAN UNION
(OJ C 115/47 of 9 May 2008)

TITLE XIX
RESEARCH AND TECHNOLOGICAL DEVELOPMENT AND SPACE [. . .].

Article 189
1. To promote scientific and technical progress, industrial competitiveness and the implementation of its policies, the Union shall draw up a European space policy. To this end, it may promote joint initiatives, support research and technological development and coordinate the efforts needed for the exploration and exploitation of space.
2. To contribute to attaining the objectives referred to in paragraph 1, the European Parliament and the Council, acting in accordance with the ordinary legislative procedure, shall establish the necessary measures, which may take the form of a European space programme, excluding any harmonisation of the laws and regulations of the Member States.

3. The Union shall establish any appropriate relations with the European Space Agency.

4. This Article shall be without prejudice to the other provisions of this Title.
ESA cooperation with EU Member States
Cooperation in support of “Europe” : socio-economic and political considerations

Recent events

- New space programmes and activities, with significant involvement of the EU (Galileo, GMES);
- Recent enlargement of the EU. Further enlargement?
- European Space Policy adopted on 22 May 2007 by 29 states (members of EU and ESA);
- Request by 2005 ESA MC to “adapt ESA’s institutional framework for associating all interested European states in its space programmes with a view to reinforcing trans-European cohesion.”
- Lisbon Treaty;
- Restructuring of European space industry.
ESA and new(er) Member States of EU

Raison d’être

• Need for ESA to involve in its activities those EU Member States that are not (or not yet) ESA Members.

• All of the countries concerned have expressed their interest to participate in ESA’s activities. Some signed cooperation agreements even before joining the EU.
ECS Agreement

• ESA created the special status of European Cooperating State in March 2001.

• A new status granted to those EU Member States that wish to have closer relations with ESA and ultimately to accede to the ESA Convention.

• Duration of the Agreement: in principle five years.

• Previous Cooperation Agreement ceases to exist.
Status

• Hungary signed a Cooperation Agreement in 1991, which was renewed. It signed the ECS Agreement in April 2003. The current PECS runs until November 2008. Hungary has formally applied to become a member state. It has in the meantime agreed to renew the ECS Agreement for another period in order to better prepare for membership.

• The Czech Republic signed a Cooperation Agreement in 1996, which was renewed. It signed the ECS Agreement in November 2003. The current PECS runs until November 2009. The Czech Republic and ESA signed the Accession Agreement on 8 July 2008, which entered into force on 12 November 2008.
Status (cont’d)

• Romania signed a Cooperation Agreement in 1992, which was renewed. It signed the ECS Agreement in February 2006. The PECS was signed in February 2007. Romania has applied for membership and accession agreement will be signed on 20 January 2011.

• Poland signed a Cooperation Agreement in 1994, which was renewed. It signed the ECS Agreement in April 2007. The implementing PECS was signed on 28 April 2008.

• Estonia signed a Cooperation Agreement on 20 June 2007. It signed the ECS Agreement on 10 November 2009. PECS was signed on 22 September 2010.

• Slovenia signed a Cooperation Agreement on 9 June 2008. It signed the ECS Agreement on 22 January 2010. PECS was signed on 30 November 2010
Cooperation agreements with other Central and Eastern Europe, status

• Latvia signed on 23 July 2009
• Cyprus signed on 27 August 2009
• Slovakia signed on 28 April 2010
• Lithuania signed on 7 October 2010
• Discussions ongoing with Bulgaria and Malta
Enlargement
• Ireland signed Convention on 31 December 1975, ratification was deposited on 10 December 1980, i.e. after entry into force;

• Austria started participation in some optional programmes in 1973 with specific agreements – no Framework Cooperation Agreement. Association Agreement signed in October 1979. Membership in December 1986;

Finland started cooperation after the entry into force of the Convention. Association agreement was signed in September 1986. Membership in 1994;


Luxembourg participated in some optional programmes with specific agreements. Membership since June 2005;

Czech Republic signed ECS agreement in 2003 and became an ESA member state on 12 November 2008.

Romania signed a Cooperation Agreement in 1992, which was renewed. It signed the ECS Agreement in February 2006. The accession agreement will be signed on 20 January 2011.
ANNEX
ESA’S SPACE PROGRAMMES
ESA’s Remarkable Pioneers of Science

- **Hipparchos** - most comprehensive star-mapper (1989-93)
- **IUE** - longest-living orbiting observatory (1978-96)
- **Giotto** - closest ever flyby of a comet nucleus (1986)
- **Ulysses** - first craft to fly over Sun’s poles (1990-2008)
- **ISO** - first European infrared observatory (1995-98)
- **SMART-1** - first European mission to the Moon (2003-06)

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MARS EXPRESS

FIRST EUROPEAN MISSION TO MARS (2003)

- Returning breathtaking high-resolution 3D images
- Finding water ice and traces of methane, possible conditions for life...
- First mission to probe beneath Martian surface

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FIRST LANDING ON A WORLD IN THE OUTER SOLAR SYSTEM

In 2005, ESA’s Huygens probe made the most distant landing ever, on Titan, the largest moon of Saturn (about 1.427 million km from the Sun).
Some of the missions now exploring our Solar System and helping us to understand our Universe:

- Hubble (1990-)
- SOHO (1995-)
- XMM-Newton (1999-)
- Integral (2002-)
- Rosetta (2004-)
- Venus Express (2005-)

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- **Herschel/Planck** - two missions studying different aspects of our cosmic origins (2009).

- **LISA Pathfinder** - testing technologies for gravity wave detection (2010).

- **Gaia** - mapping a thousand million stars in our galaxy (2011).


- **BepiColombo** - a satellite duo exploring Mercury (2013).
Herschel, the infrared observatory
Planck, the coldest known object in space (-273.05 °C)
ESA’s launchers 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 (first launch due in 2010).
HUMAN SPACEFLIGHT
COLUMBUS

7 February 2008 - Columbus launched on board Space Shuttle Atlantis. Now an integral part of the ISS, this is the first European laboratory dedicated to long-term experimentation in weightlessness.

ESA astronauts Hans Schlegel (D) and Léopold Eyharts (F) were essential team members on this assembly and commissioning mission.

Columbus offers unique opportunities for research in microgravity, adding value to science on Earth – as an extended part of ground-based research and industry infrastructures.
A series of autonomous spacecraft designed to resupply and reboost 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 on 9 March 2008 by Ariane-5 from Europe’s Spaceport in Kourou, French Guiana. On 3 April, it docked automatically with the ISS. At least another 4 ATVs are planned, one launched every 17 months.
EUROPEAN ASTRONAUT CORPS
1968 - Europe started to develop communications satellites, launching the Orbital Test Satellite (OTS) 10 years later. OTS was used for more than 13 years by ESA and Eutelsat.

Olympus, 1989 - this experimental satellite was the largest civilian telecommunications satellite in the world at the time of launch.

Artemis, 2001 - introducing a new era of telecommunication services to the world, with this latest multi-purpose telecommunications and technology demonstration satellite.
ARTES (Advanced Research on Telecommunication Satellites) – looking at innovative ways of developing and using communications technology.

Alphasat/Alphabus – Partnership (after competition) with a Telecom Operator to develop a high-power communications satellite by a joint industry team.

Small GEO – Partnership (after competition) with a Telecom Operator to develop a medium-size telecommunications satellite by a joint industry team.
Putting Europe at the forefront of this strategically and economically important sector, **Galileo** will provide a highly accurate, guaranteed global positioning service under civil control (www.esa.int/navigation).

Many applications include value-added services for transport by road, rail, air and sea, fisheries and agriculture, oil-prospecting, civil protection, building, public works and telecommunications.

A joint effort between ESA and the EU, expected to generate and more than 100 000 highly qualified jobs in Europe.

**GIOVE-A** - first Galileo satellite, 2005  
**GIOVE-B** - second, launched on 27 April 2008
EARTH OBSERVATION
**PIONEERS IN EARTH OBSERVATION**

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


**Envisat**, 2002 - the largest Earth observation spacecraft ever built, it provides continuous monitoring of Earth’s surface, atmosphere, oceans and ice caps.

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A radar view of the Earth: ERS, ENVISAT
ESA's Living Planet Programme comprises two main components:
- a science and research element (includes Earth Explorer missions),
- the Earth Watch element.

Earth Watch delivers Earth observation data for use in operational services, and includes the well-established meteorological missions with Eumetsat, and also new missions focusing on the environment and civil security under the GMES initiative.
These missions address critical and specific issues raised by the science community, while demonstrating the latest observing techniques. They focus on the atmosphere, biosphere, hydrosphere, cryosphere and Earth’s interior.

GOCE (March 2009)
SMOS (2009)
ADM-Aeolus (2009)
CryoSat-2 (2009)
Swarm (2010)
EarthCARE (2013)

A 7th Earth Explorer will be selected in 2009.

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Gravity field map and improved global geoid models

Improved understanding of ocean circulation and energy distribution

Global unification of height systems
GOCE’s first global gravity model
**In space since Nov. 2009**

- Calibration / validation ongoing

**Applications:**

- Improved models of global water cycle
- Monitoring and modelling of ocean circulation
- Improved management of water resources
Arctic sea-ice extent has shrunk by 2.7% per decade since 1978

ESA’s CryoSat mission shall lead to a better understanding of the role ice plays in the Earth system
'Living Planet' also includes the next generation of missions dedicated to weather and climate.

**Meteosat Third Generation** - will take over from Meteosat 11 in 2015, the last of four MSG (Meteosat Second Generation) satellites. MSG is a joint project between ESA and Eumetsat following the success of the first-generation Meteosat satellites.

**MetOp** - a series of three satellites to monitor climate and improve weather forecasting, the space segment of Eumetsat's Polar System (EPS). MetOp-A (2006-) is Europe's first polar orbiting satellite dedicated to operational meteorology.
Global Monitoring for Environment and Security

European independence in data sources for environment and security monitoring and
The European contribution to the Global Earth Observation System of Systems (GEOSS)
Joint Infrastructure: National, EUMETSAT and Third Party Missions

- Terrasar-X
- Rapideye
- Pleiades
- Jason-2
- CosmoSkymed
- TopSat
- Radarsat
- SPOT
- UK-DMC
- METOP
GMES Service Element

Fast Track Services

- Emergency Respond
- Land Monitoring
- Marine Services
- Atmosphere (Pilot)
- Security (Pilot)

100 M€ by ESA MS
330+ user organisations
EC has invested another 100 M€
Sentinel 1 – SAR imaging
All weather, day/night applications, interferometry

Sentinel 2 – Multispectral imaging
Land applications: urban, forest, agriculture,..
Continuity of Landsat, SPOT  

Sentinel 3 – Ocean and global land monitoring
Wide-swath ocean colour, vegetation, sea/land  
surface temperature, altimetry

Sentinel 4 – Geostationary atmospheric
Atmospheric composition monitoring, trans-boundary pollution 

Sentinel 5 and Precursor – Low-orbit atmospheric
Atmospheric composition monitoring 

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Climate Change Initiative

The rationale:
To systematically generate and distribute long-term series of "Essential Climate Variables" (ECV) to meet needs of UNFCCC and IPCC, based on ESA archived EO data.

The Output:
- **ECV Records**: Quantifying the state of the Climate system to (a) advance our knowledge, and (b) support work of UNFCCC and IPCC for climate change mitigation and adaptation.

The Resources:
- 6 years / 75 Million Euro

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Increase of atmospheric temperature
(J. Hanson, R. Ruedy, M. Sato, K. Lo, NASA Goddard)
(a) Global-Mean Surface Temperature Anomaly (°C)

Sea level rise from satellite data 1992 – 2006

Overall trend: 3.22 mm/yr
Common annual signal removed

Courtesy of Remko Scharroo, Altimetrics LLC, New Hampshire, USA, 2006
Emergency relief

The International Charter on Space and Major Disasters

- Data acquisition in case of natural or human-made disasters
- Data delivery to civil protection agencies, emergency & rescue services

Examples of activations:
- Bam Earthquake 2003
- Darfur Crisis 2004
- Tsunami Catastrophe 2004/2005
- Hurricane Katrina 2005
- Sichuan earthquake 2008
- Hurricanes Gustav, Ike 2008
- Haiti earthquake 2010
Encounter B-9B and Mertz Glacier Tongue = birth of C-28

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**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
- **Navigation:** Galileo (with EU)
- **Launch services:** Arianespace
- **Telecomms:** Eutelsat and Inmarsat
Thank you !!

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