esa

1964-2014

→ SPACE FOR OUR FUTURE

Boosting Europe's competitiveness and growth

European Space Agency

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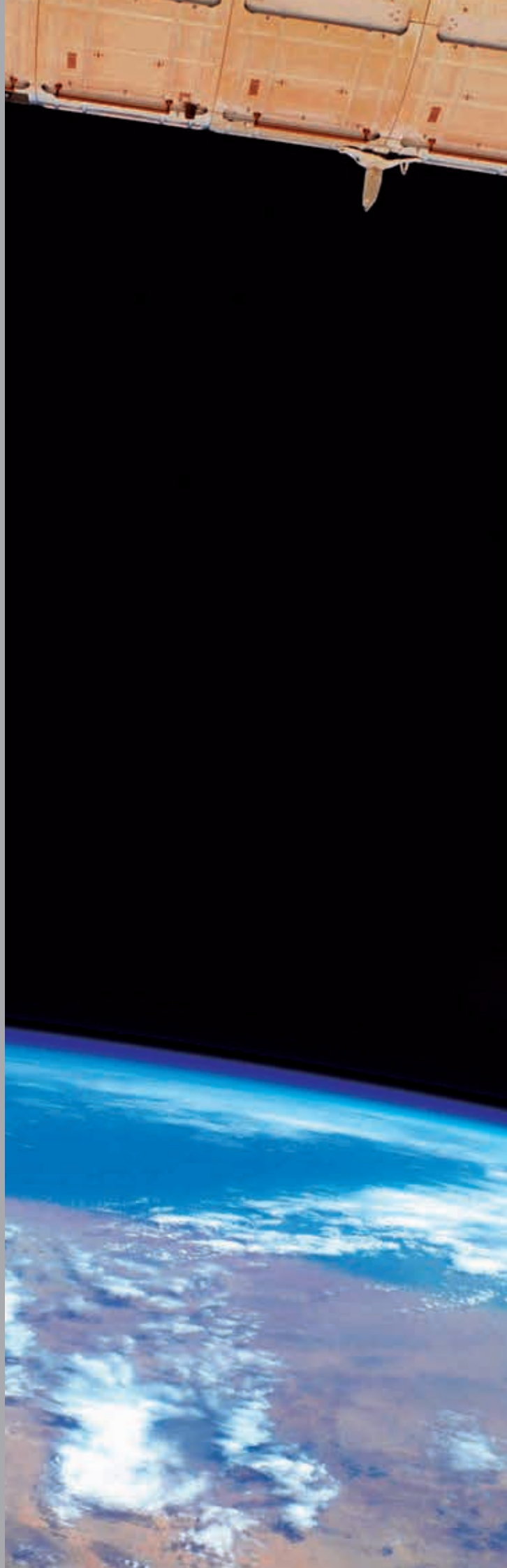
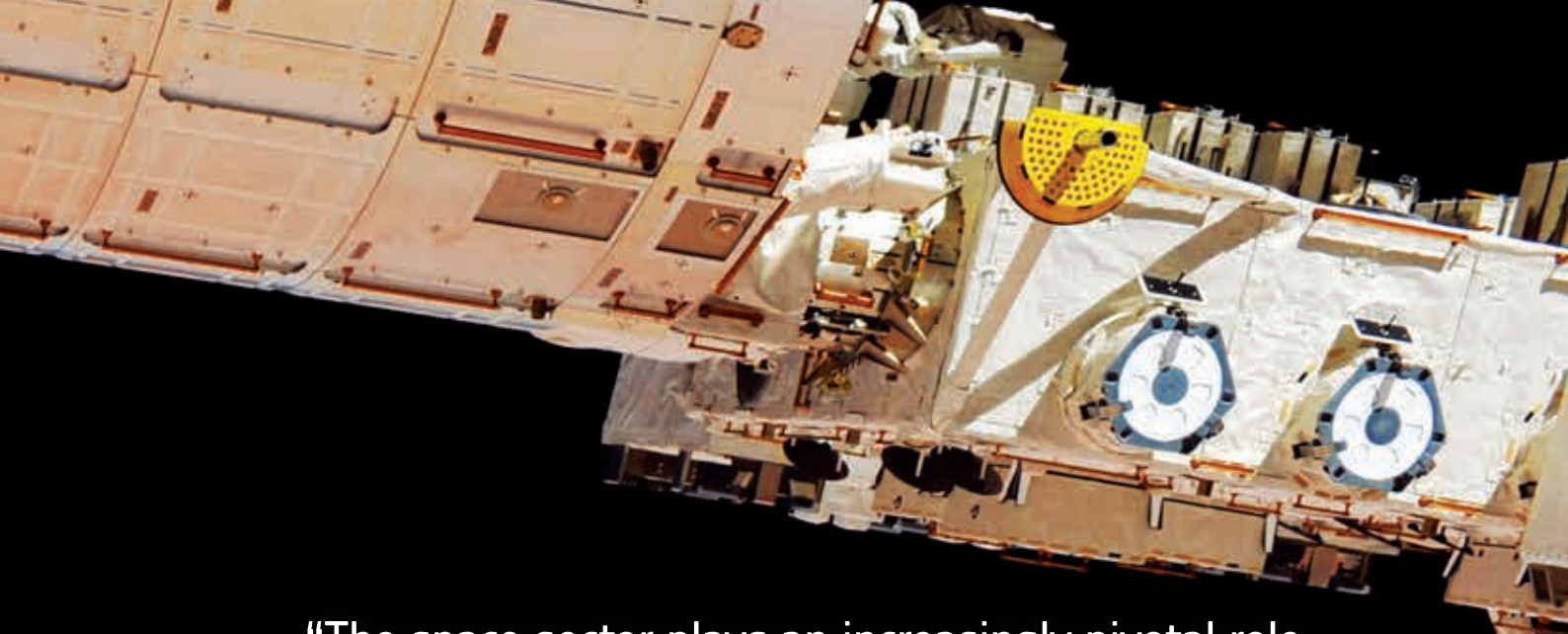
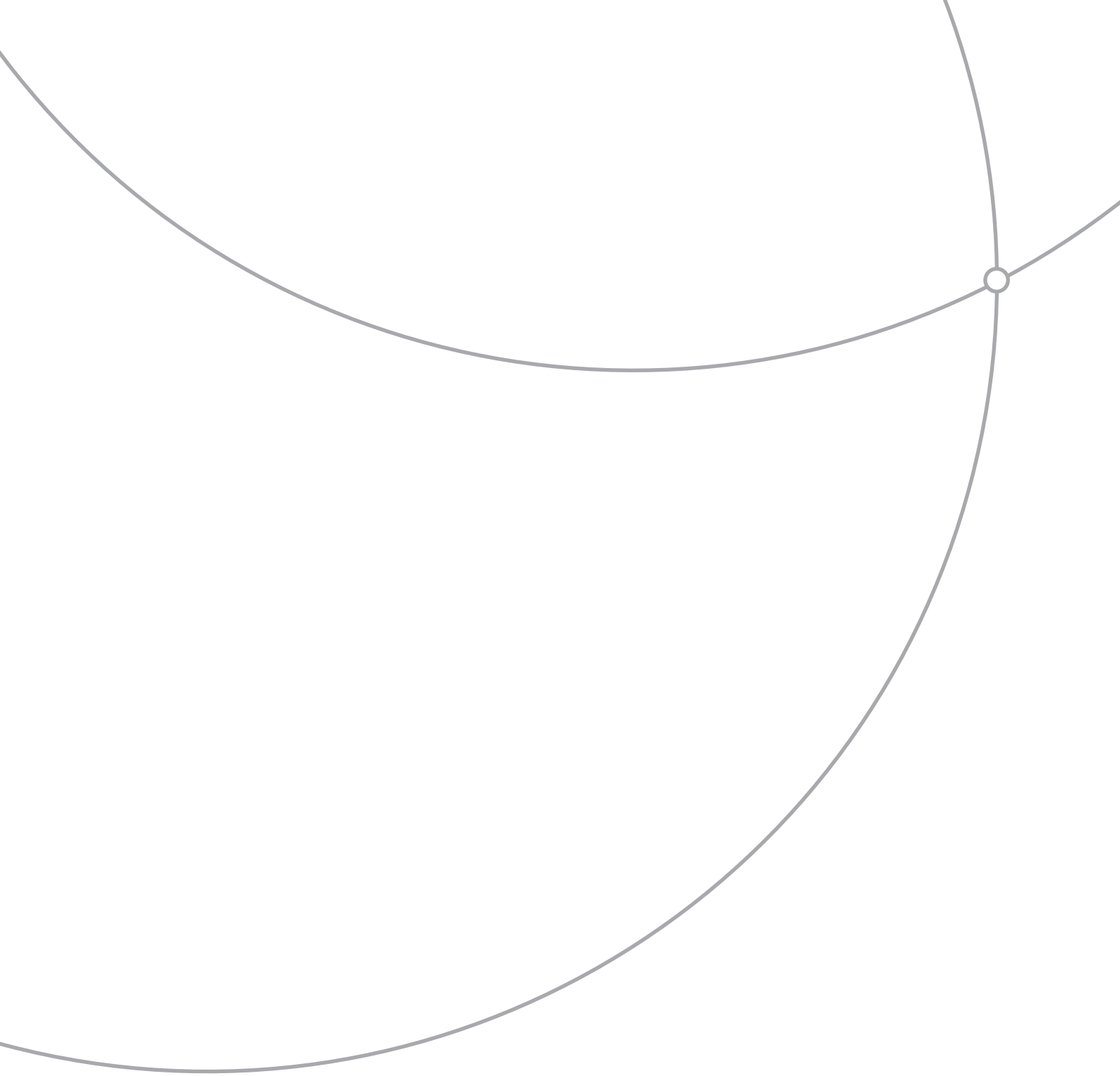




"The space sector plays an increasingly pivotal role in the efficient functioning of modern societies and their economic development. The use of satellite technology in navigation, telecommunications, meteorology, and Earth observation is giving rise to a growing stream of applications in such areas as air traffic control, transport, natural resource management, agriculture, environmental and climate change monitoring, entertainment and so on, which in turn are creating new downstream uses and new markets. Space is increasingly seen as an important potential source of economic growth, social wellbeing and sustainable development."

OECD

The Space Economy at a Glance 2011, OECD Publishing



→ INTRODUCTION

Space is a strategic asset and is of fundamental importance for the independence, security and prosperity of Europe. It is an enabling tool that gives Europe's decision-makers the ability to respond to critical challenges such as global climate change and global security. It brings a significant contribution to Europe's growth and employment; it provides indispensable enabling technologies and services for the knowledge society; it increases the understanding of our planet and Universe; and it contributes to European identity, cohesion and security, providing inspiration for future human potential and drawing young people to scientific and technical education.

At this time of unprecedented economic challenges, space is proving to be an anchor of stability and a counterbalance to negative trends. Space-based services are having an increasing effect on our way of life. Competitiveness fosters growth. Increasing the competitiveness of the European space industry and operators on world markets, whether in infrastructures or services, and increasing the competitiveness of space-based services compared to ground-based services will contribute to growth in Europe.

This brochure provides an overview of the main benefits that space provides to our modern society, and to Europe in particular, thanks to the successful cooperation of Member States through ESA, the space agency for Europe:

- Space to build our future
- Space for protecting our environment
- Space for improving our everyday life
- Space for living safely
- Space for boosting economic growth
- Space to stimulate our need for knowledge
- Space: a multiplier for economic growth and a European success story

→ SPACE TO BUILD OUR FUTURE

Exploration has always been a source of knowledge and progress for civilisations. Space exploration is no exception. Space is indispensable for pushing the frontier of our knowledge and understanding our physical environment for the benefit of all humankind. In a rapidly changing world, space provides Europe with an unprecedented opportunity for consolidating its global role. Space is an essential tool for building Europe's future.

Europe is **n°1** in space science, Earth observation and commercial launch services.

Galileo, Europe's future navigation system, has the potential for **2400** million users by 2020.

Between 1996 and 2014, there were **74** commercial launches of Ariane 5, with a **97%** success rate.

INSPIRATION + INNOVATION + DISCOVERY = OUR FUTURE

Space exploration engages and **inspires** the public and encourages students to pursue studies in challenging, high-tech fields.
The demanding requirements of space programmes are fuelling the creation of **innovative** capabilities in Europe and the development of key technologies that improve our daily life and prepare for the future.
Space exploration allows us to understand and protect our planet better, advances our knowledge, and allows us to **discover** the answers to fundamental questions about the history of Earth, the origin of life, the Solar System and the Universe.

A KEY ASSET FOR EUROPE

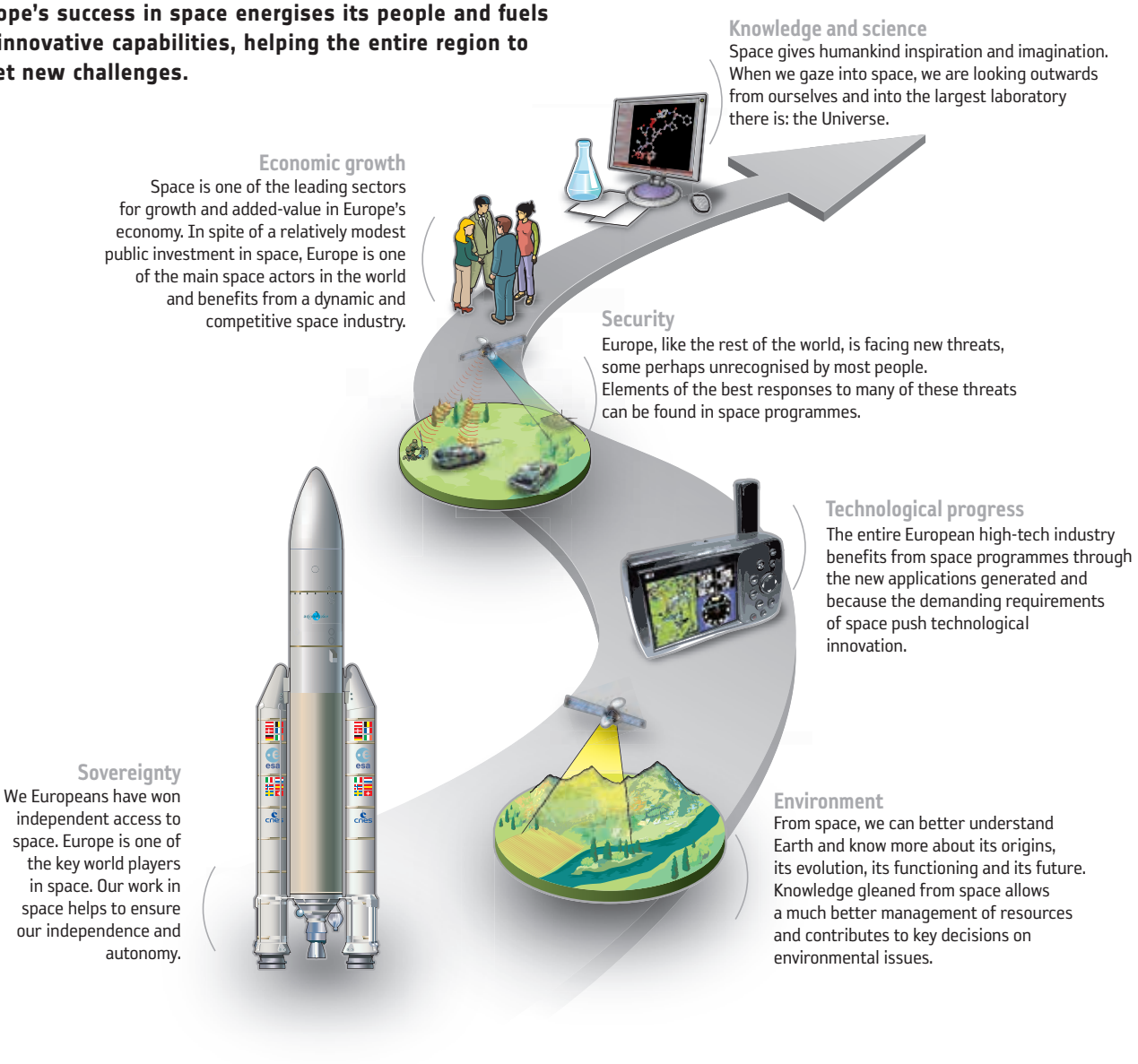
Space reinforces Europe's position as a major player on the world stage and as a bridge-builder between current and emerging powers.
The strategic information flowing from space is strengthening Europe's credibility when it comes to raising the world's awareness on major issues, such as climate change.
Space is helping Europe to prepare for tomorrow's challenges, whether in protecting our environment, preserving natural resources, strengthening the competitiveness of our economy or facing new threats.

A FRUITFUL COLLABORATION BETWEEN 20 EUROPEAN COUNTRIES

Space is a successful model for European cooperation, helping to ensure peace, economic growth and social progress for us all. Based on the principle of cooperation, ESA now unites 20 countries; in addition, several other European states have expressed their wish to join the organisation. They are attracted by a model built upon cultural

→ SPACE: A MOTOR DRIVING EUROPE

Europe's success in space energises its people and fuels its innovative capabilities, helping the entire region to meet new challenges.



Knowledge and science
Space gives humankind inspiration and imagination. When we gaze into space, we are looking outwards from ourselves and into the largest laboratory there is: the Universe.

Economic growth
Space is one of the leading sectors for growth and added-value in Europe's economy. In spite of a relatively modest public investment in space, Europe is one of the main space actors in the world and benefits from a dynamic and competitive space industry.

Security
Europe, like the rest of the world, is facing new threats, some perhaps unrecognised by most people. Elements of the best responses to many of these threats can be found in space programmes.

Technological progress
The entire European high-tech industry benefits from space programmes through the new applications generated and because the demanding requirements of space push technological innovation.

Sovereignty
We Europeans have won independent access to space. Europe is one of the key world players in space. Our work in space helps to ensure our independence and autonomy.

Environment
From space, we can better understand Earth and know more about its origins, its evolution, its functioning and its future. Knowledge gleaned from space allows a much better management of resources and contributes to key decisions on environmental issues.

diversity, open-mindedness, fairness, excellence and collaboration, which has allowed Europe to become a world leader in space science, Earth observation and commercial launch services and a world-class player in all other domains.

SPACE GUARANTEES EUROPE'S SOVEREIGNTY

Over the past 40 years, ESA has created five versions of Europe's own highly reliable Ariane launchers and recently added Vega and Soyuz to complete the range of launch services offered by Europe. Now, with a secured route to space and a convincing presence in human and unmanned operations in orbit, including major involvement in the International Space Station, Europe is able to influence the international debate on the use of space. This is essential for preserving its independence and autonomy. There is no doubt that its activities in space are strengthening Europe's standing in the world, promoting its vision and supporting its international policies.

→ SPACE FOR PROTECTING OUR ENVIRONMENT

How is our planet evolving and why? What is its future? To answer such questions, we must look at Earth from above. Satellites play an invaluable role in helping scientists to advance our understanding of Earth. And that is why many ESA projects are focused on exactly that goal.

53 000
Times
ESA's Envisat Earth observation satellite orbited Earth from its launch in 2002 until 2012. Data collected during these satellite passes were constantly feeding into more than 6000 scientific projects. An outcome of one project is the 'Air Quality Platform for Europe' which provides forecasts on air quality for up to
3 days.

OBSERVING EARTH FROM ABOVE

Our climate is changing dramatically with sea-surface temperatures and sea levels rising, polar ice sheets disintegrating, glaciers retreating and weather patterns changing. Earth observation satellites are monitoring these changes continuously on a global scale, providing scientists with essential information for developing models and improving the understanding of Planet Earth.

ESA's Envisat was the most sophisticated environmental satellite ever put into orbit. Following its launch in 2002, it provided invaluable information for global monitoring and forecasting. ESA's series of Earth science satellite missions – the Earth Explorers – are delivering an even more detailed picture of our planet. Being launched since 2009, these satellites are gathering specific information for climate change research. They are monitoring global gravity, soil moisture, ocean salinity, ice coverage, the magnetic field, wind profiles and cloud coverage.

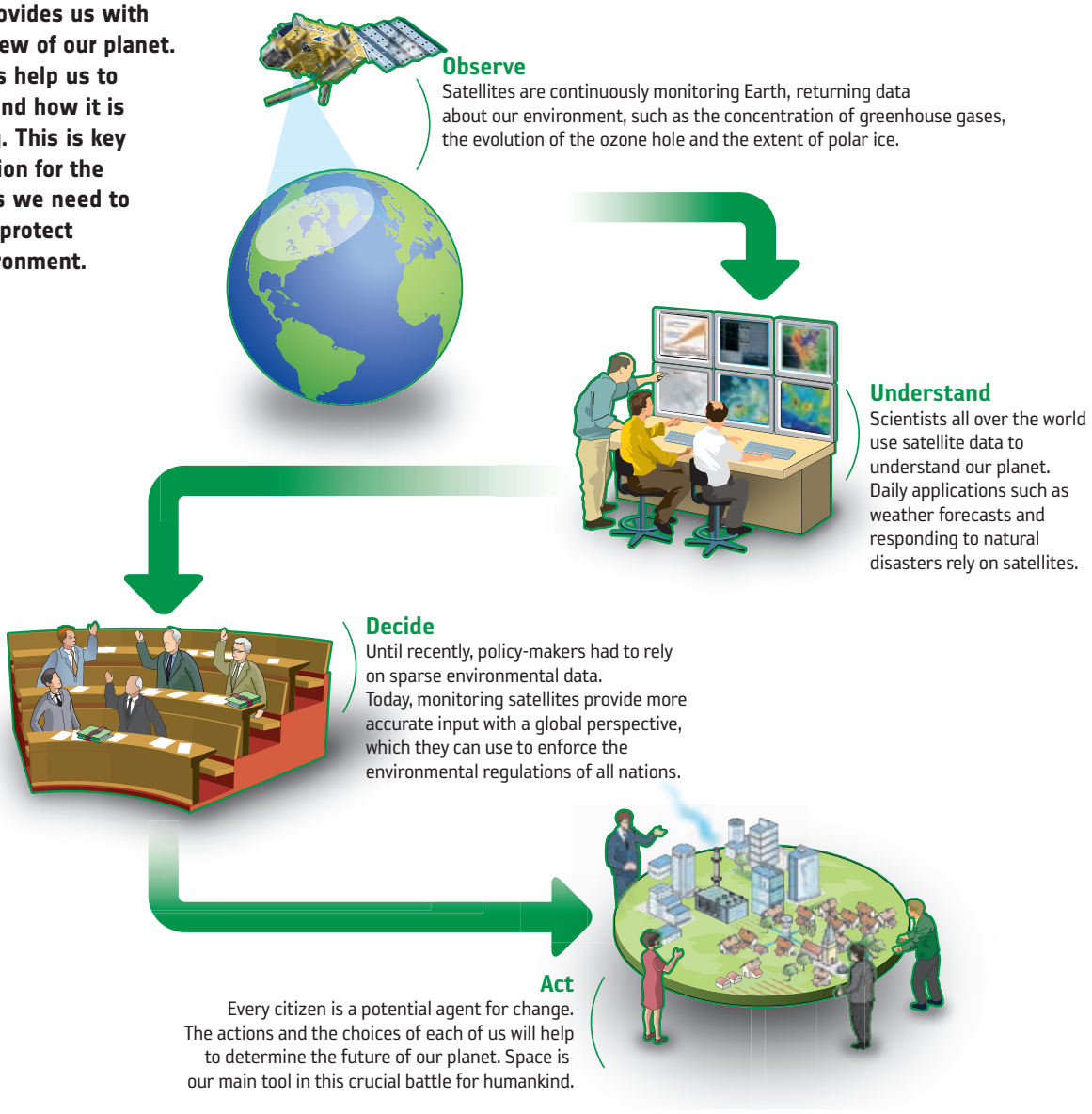
SPACE AS A TOOL TO SUPPORT DECISION-MAKERS

In order to face the challenges of climate change, decisions must be based on reliable and independent environmental information. With their unique view from space, satellites provide a consistent set of continuously updated global data about Earth's atmosphere, land, sea and ice.

For instance, Envisat detected and mapped global air pollution. These measurements led to the development of an innovative service that delivers air pollution alerts via text messages to people who suffer from asthma, emphysema, bronchitis and heart disease. These forecasts help sufferers to reduce their exposure to air pollution and to manage their symptoms better.

→ UNDERSTANDING EARTH TO PRESERVE ITS FUTURE

Observing Earth from space provides us with a new view of our planet. Satellites help us to understand how it is changing. This is key information for the decisions we need to make to protect our environment.



Observe
Satellites are continuously monitoring Earth, returning data about our environment, such as the concentration of greenhouse gases, the evolution of the ozone hole and the extent of polar ice.

Understand
Scientists all over the world use satellite data to understand our planet. Daily applications such as weather forecasts and responding to natural disasters rely on satellites.

Decide
Until recently, policy-makers had to rely on sparse environmental data. Today, monitoring satellites provide more accurate input with a global perspective, which they can use to enforce the environmental regulations of all nations.

Act
Every citizen is a potential agent for change. The actions and the choices of each of us will help to determine the future of our planet. Space is our main tool in this crucial battle for humankind.

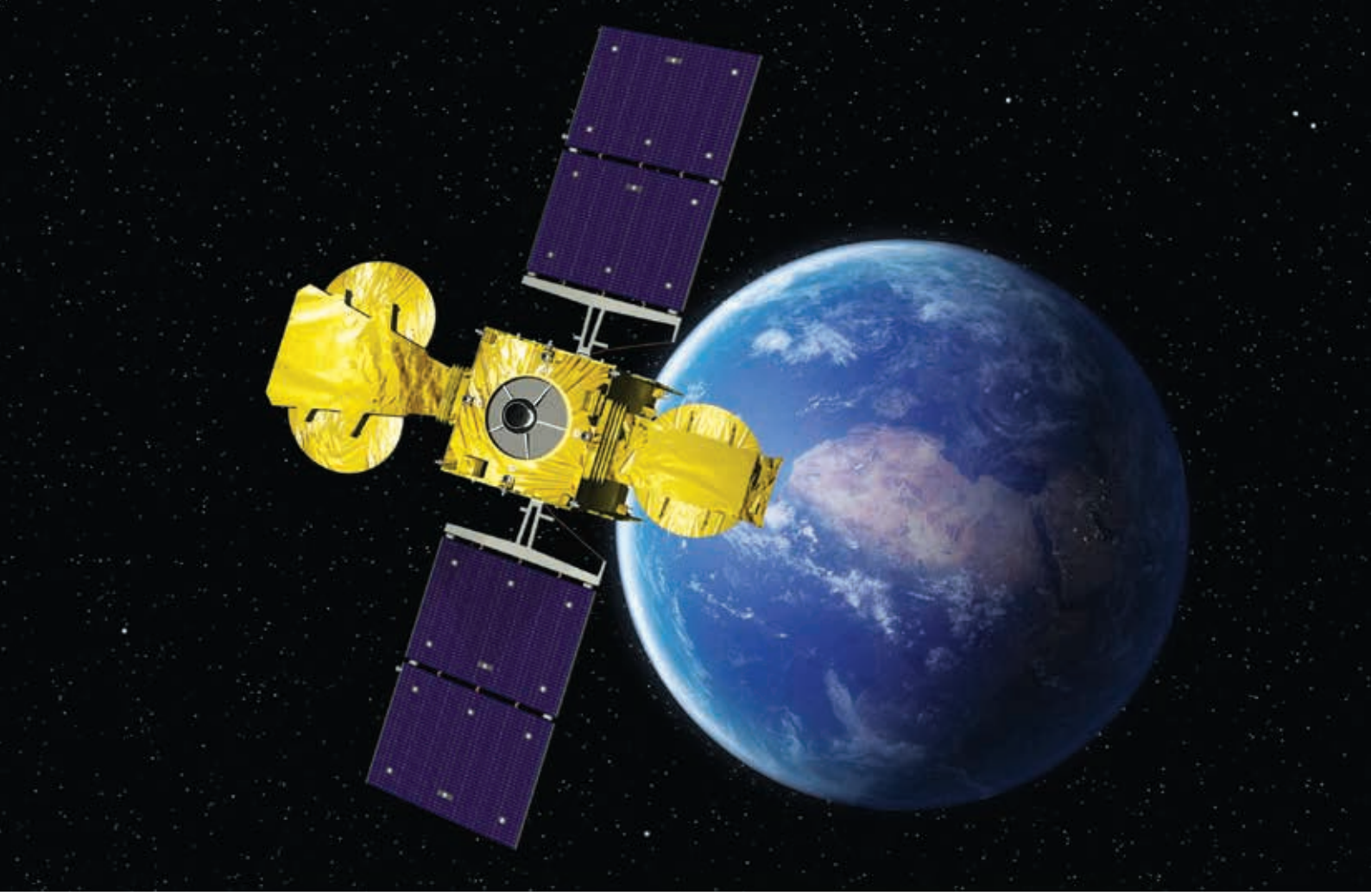
BETTER MANAGEMENT OF DISASTERS

Natural and man-made disasters take a staggering toll in economic and human terms. Effective early-warning systems and vulnerability mapping are essential for mitigating their effects. Data collection and efficient dissemination procedures are crucial for risk-management activities. Here, too, satellites can help. For instance, satellites have contributed to tripling the warning time for tropical cyclones and hurricanes – from 24 hours in 1990 to 72 hours today.

With the Copernicus programme, ESA and the European Commission are going a step further. The objective is to combine all available space- and ground-based information sources to monitor the environment and to provide realtime access to these data to end users, including policy-makers. This will improve our capacity to forecast natural disasters and significantly reduce their human and financial impacts.

Satellite image of Hurricane Ivan, 2004.

→ SPACE FOR IMPROVING OUR EVERYDAY LIFE



Space applications play an essential and growing role in our daily activities, even if we don't necessarily notice them. Space helps us when we're at home and when we're on the move. Space makes broadband Internet available even in remote parts of the globe. And space contributes to economic development and social progress.

5500
the number of TV programmes broadcast by satellites to
150 million
homes in Europe.

A LIFE FULL OF SPACE

Although we don't always notice, we use products every day that rely on 'space'. When we are looking at a weather forecast, watching TV, surfing on a high-speed Internet connection, using our telephone or a GPS receiver to find our way, we are benefiting from technological advances brought into our lives from space. And there is still much more to come.

Satellite applications are at the core of this rapid and accelerating pace of innovation. Their benefits are already substantial in leisure, education, health and the economy. Public authorities use satellite data and applications to provide better services, to preserve our environment and to improve security.

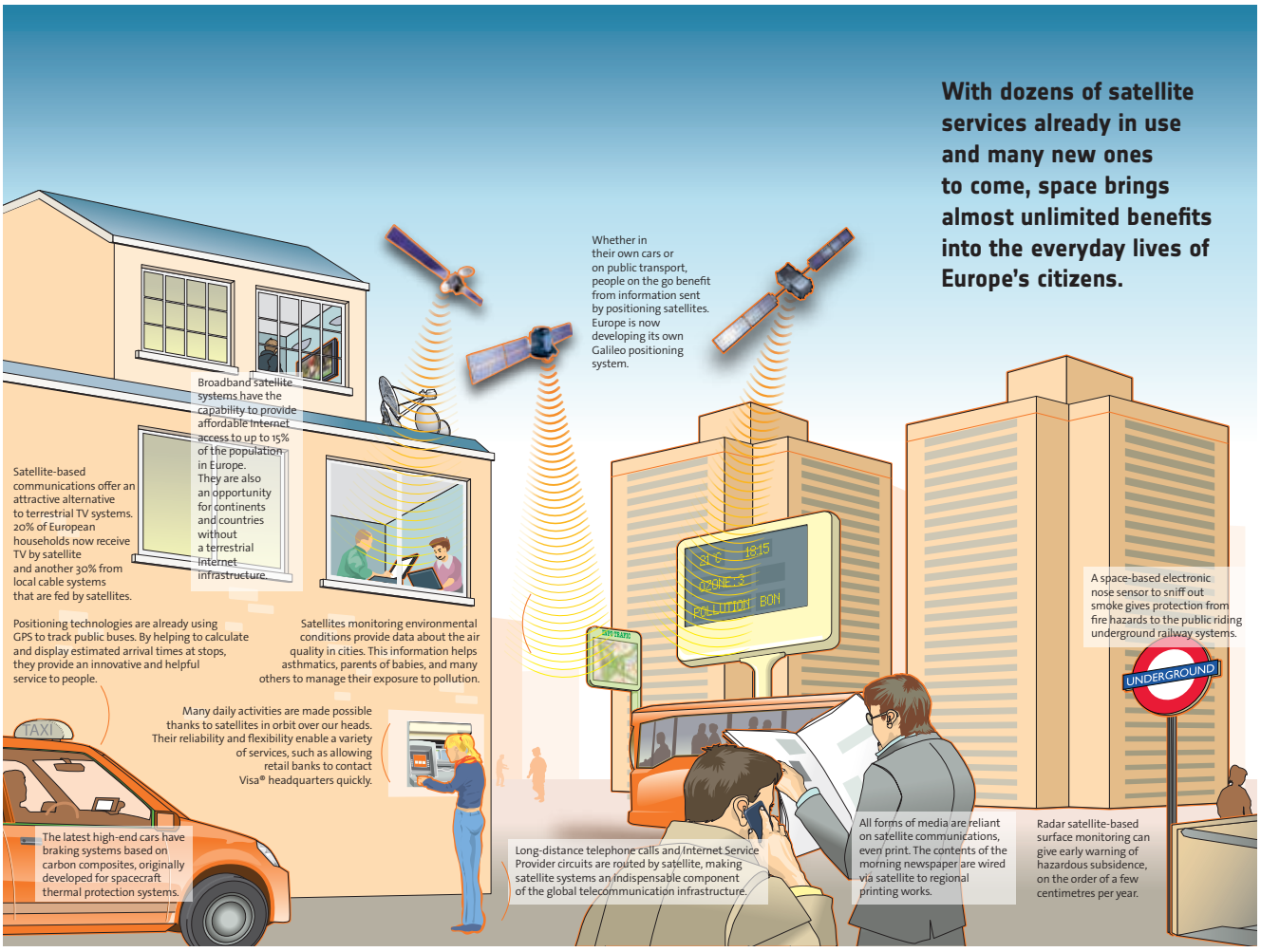
CONTRIBUTING TO SOCIAL PROGRESS

Space is helping to build better infrastructures in Europe and around the world, contributing to economic development and social welfare.

Satellites offer affordable communications to the great majority of European citizens. For people living outside of the more developed urban areas, there are still no terrestrial cables or wireless links to provide broadband Internet access. In the coming years, space will bring broadband access to each and every home in Europe – thanks to new telecommunications satellites.

Telecommunications satellites have many more applications. For example, they

→ SPACE: HIGH ABOVE BUT CLOSE TO OUR LIVES



improve access to medical services or, when combined with Earth observations satellites, they can help fisheries and farms to optimise their use of natural resources.

WHEN SPACE MAKES THE SKY SAFER

Space is a key to building safer and more efficient transport systems. Satellites are already helping to manage road and air traffic. In the near future, once the Single European Sky initiative is in place, their contribution to Air Traffic Management will be crucial. With the global growth of air traffic, all civil aviation authorities, including Eurocontrol, agree that the current system urgently needs added capacity to avoid increasing congestion on the ground and in the sky. Pilots and flight controllers will benefit greatly from exchanging data and communicating via satellite. This will allow air traffic controllers to route aircraft more efficiently, which will result in significant economic benefits for airlines, shorter trip times for passengers and reduced impact of air transport on the environment.

Thanks to satellites monitoring the weather, providing communications and allowing reliable navigation, new and safer sky highways will become a reality. Thanks to space, these new sky highways will result in significant economic benefits as well as environmental benefits – a reduction of 20 million tonnes of carbon dioxide a year.

Modernising air traffic management communications.

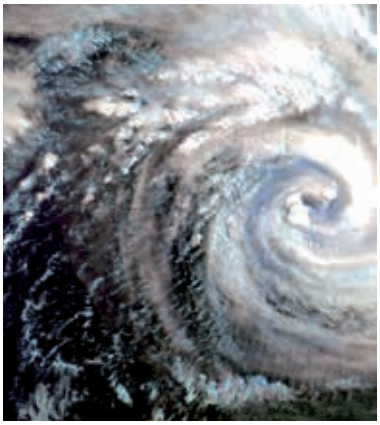
→ SPACE FOR LIVING SAFELY

Space applications allow authorities to anticipate and face new threats with flexible and tailored solutions. Thanks to such applications, Europe can optimise its 'observation–orientation–decision–action' chain, support its interests around the globe, and improve its reaction to natural or manmade disasters.

Earth observation and communication satellites have improved the prediction time for tropical cyclones and hurricanes, from 24 hours in 1990 to

72

hours today.



Satellite image of tropical cyclone Ganede, 2007.

AN EYE ON THE PLANET

Defence and security policies rely on risk evaluation for prevention, information provision during the crisis and post-crisis management for reconstruction. Space applications play a major role in communications and observation systems.

Non-intrusive optical and radar imaging satellites provide a unique capability for observing the entire planet. Satellites are also vital when it comes to transferring large amounts of information.

Civil space systems such as Galileo and Copernicus will offer multipurpose capabilities and complete Europe's safety and security space assets.

IN CASE OF EMERGENCY

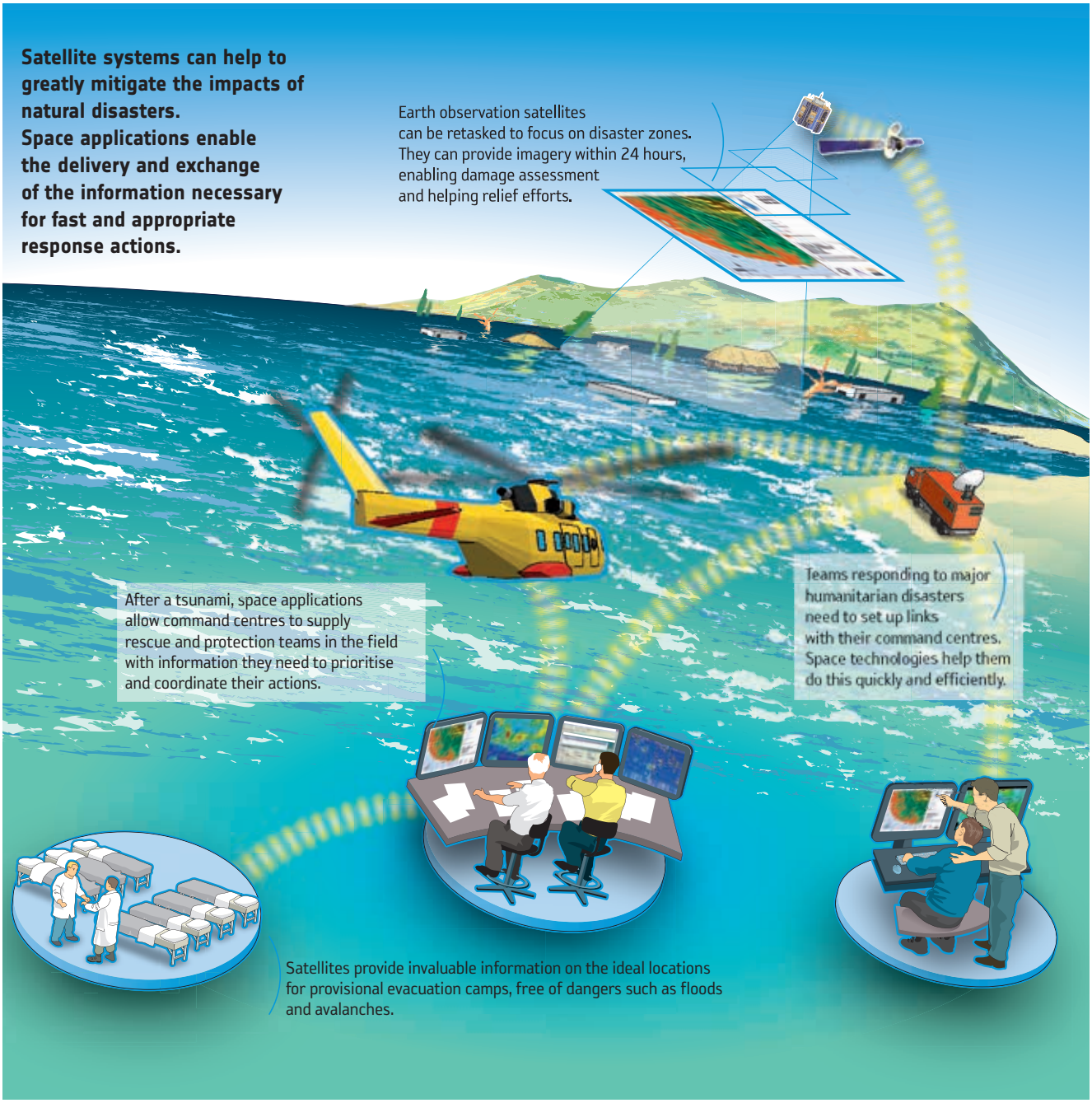
Space provides precious support during emergency situations. Today, the world is confronted with new kinds of threats, creating demands for new kinds of prevention and response. Space systems are crucial for helping authorities to analyse emergency situations and coordinate rescue operations.

In 2000, the International Charter on 'Space and Major Disasters' cooperation initiative was started to give countries in need, free access to Earth observation satellite data. Since its start, the Charter has been activated 435 times and around 120 countries have benefitted from its support.

SPACE TO HELP MANAGE MIGRATORY MOVEMENTS

Global warming is expected to have major consequences on human migration. By 2050, 150–200 million additional 'environmental refugees' are expected to be added to the millions of traditional refugees, including victims of conflicts. Satellite information helps national governments and international agencies such as the UN High Commissioner on Refugees in facing these challenges.

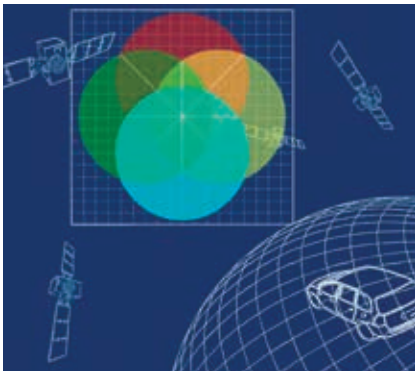
→ SPACE FOR A SAFER WORLD



REDUCING TRAFFIC RISKS

Transport plays a big role in our economy. All modes of transportation – terrestrial, maritime and airborne – are expanding. A comprehensive approach to traffic management and security is necessary, and only navigation from space applications can provide that.

Moreover, the globalisation of trade has raised issues of security. This is a particularly important topic because, increasingly, our economic prosperity means that roads, seaports and airports are critical elements of a country's infrastructure that need extra protection from external risks. Only space applications (satellites monitoring space weather, telecommunication and positioning satellites) can provide this.



Navigation by satellite.

→ SPACE FOR BOOSTING ECONOMIC GROWTH

Space is one of the leading sectors for growth and added-value in Europe's economy. It also provides an economic boost to many other sectors. And all this happens for the very modest cost to each European of €10 per year in public investment. Investments in space benefit the economy as a whole and contribute to Europe's dynamic role in a variety of highly competitive global industries.

- The overall economic impact of Galileo is estimated to be **€90 billion*** over the next 20 years
- The estimated cumulative socio-economic benefits from the MetOp-SG system for 2020–40 are not less than €15.7 billion and could range up to **€62.6 billion****
- The total revenues for the economy generated by commercial satellite systems (telecommunications, navigation & Earth observation) are 20 times the cost of the satellite infrastructures and launches themselves.***

*source: European Union
**source: Eumetsat
***source: Euroconsult & Futron

A MAJOR PLAYER IN A HIGHLY COMPETITIVE SECTOR

By channelling public funds into space-related activities for more than 35 years, the European Space Agency and the national programmes have helped to create a strong, stable and competitive European space industry. More than 36 000 men and women are employed in this sector, which has an annual turnover of €6.8 billion. But this is only the tip of the iceberg: the effect of space on Europe's economy is six times greater.

SPACE BOOSTS MANY SECTORS

More than 85% of ESA's budget is spent on contracts and partnerships with the industrial sector; thousands of contracts are signed each year with private companies of all sizes. Space activities are just a small part of a much bigger economic ecosystem. For instance, the total revenues generated by commercial satellite systems (telecommunications, navigation & Earth observation) are 20 times the investments made to manufacture and launch the satellites themselves.

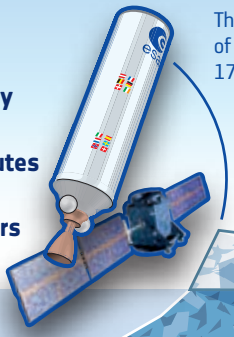
INNOVATIONS: FROM SPACE TO EARTH

By working to develop tomorrow's products and services, the space sector gives Europe a decisive technological advantage. As they develop innovative space technologies, European companies and laboratories acquire know-how and skills that can then be applied to many other fields.

Recent spin-offs from space include protective 'Hydro Jackets' for firefighters, which were based on astronaut suits for spacewalking; and the latest car airbag sensors, which were adapted from tactile sensors developed for the robotic arms of the International Space Station.

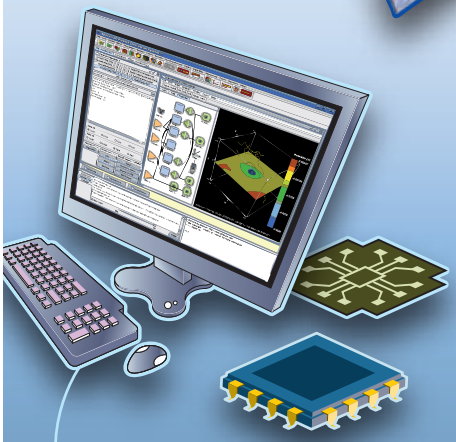
A MULTIPLIER EFFECT ON THE WHOLE ECONOMY

The effect of the space sector on the overall economy goes far beyond the mere revenues generated by the space industry and its suppliers. Boosted by a multiplier effect, space contributes to growth, employment and competitiveness in many sectors of the economy.



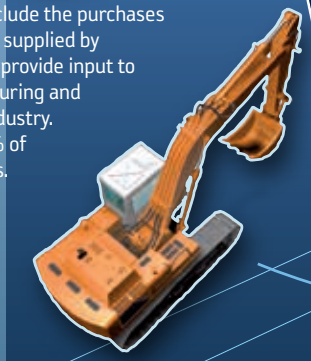
The direct revenues generated by the space sector (direct revenues of the manufacturing and satellite services industry) represent only 17% of the total financial impact of space on the economy.

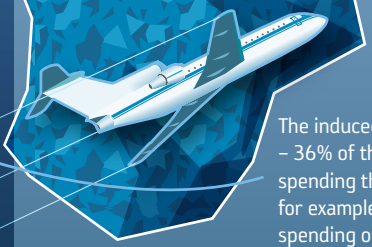
DIRECT REVENUES
17%



INDIRECT REVENUES
47%

The indirect revenues of the space sector include the purchases made by and labour supplied by the companies that provide input to the space manufacturing and satellite services industry. They represent 47% of the overall revenues.





INDUCED REVENUES
36%

The induced revenues of space on the economy – 36% of the whole – account for the increased spending that results from the industry's existence; for example, a space engineer's increased spending on goods and services.

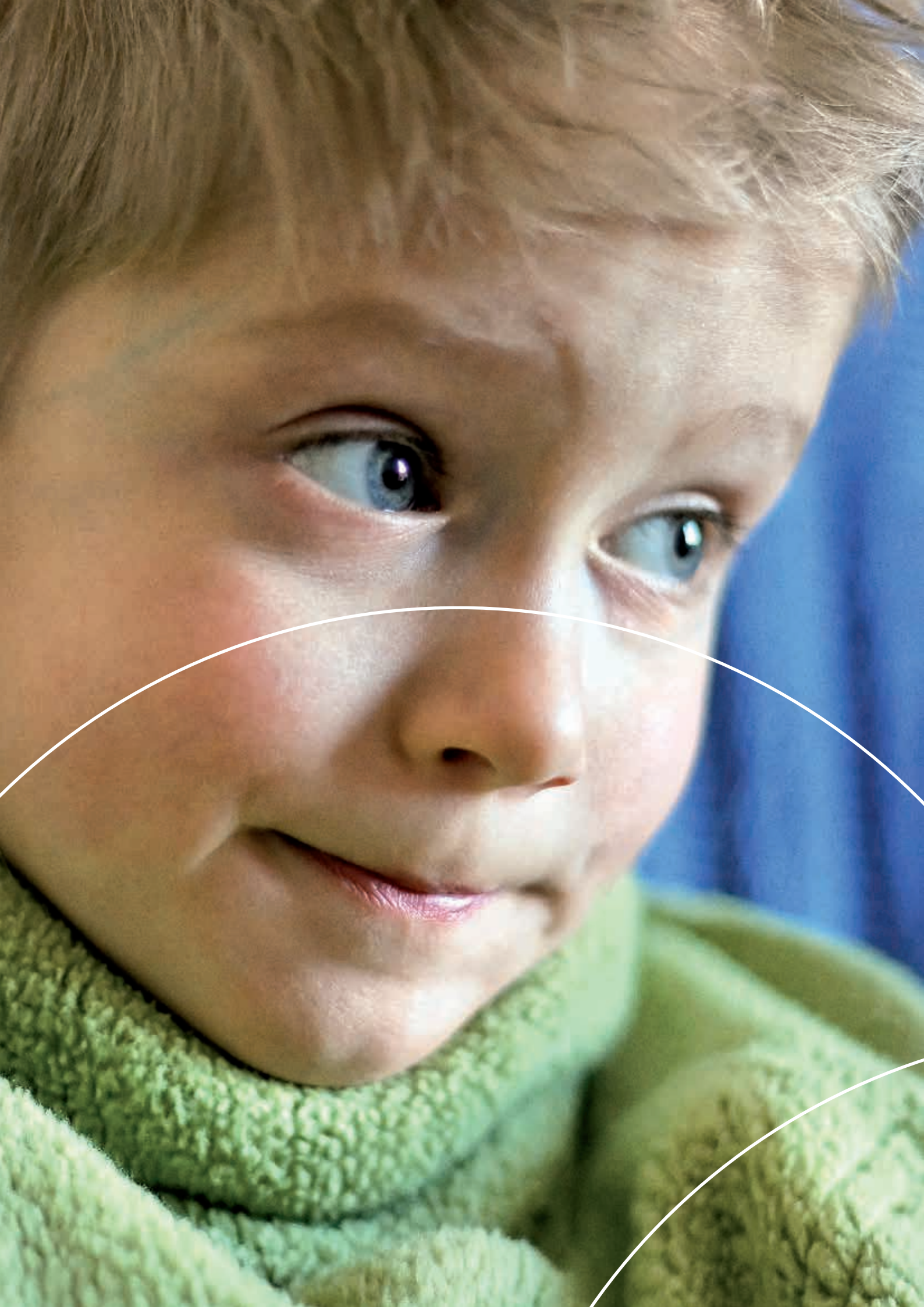
THOUSANDS OF JOBS CREATED EVERY YEAR

Space activities contribute significantly to employment and competitiveness in many sectors of the economy, including leisure, telecommunications, agriculture and the environment. At this time of unprecedented economic woes, space is an anchor of stability and a counterbalance to negative trends.

PROSPERITY FROM SPACE

The use of space technologies reduces costs and increases productivity. Space technology ranks alongside aeronautical engineering, computer applications and biomedical products as an advanced industrial element that helps Europe to prosper and grow in an increasingly competitive world. European companies have a **40%** worldwide market share in commercial satellites, and provide **more than 50%** of all commercial launches.

Preparing the ATV spacecraft.



→ SPACE TO STIMULATE
OUR NEED
FOR KNOWLEDGE

Humanity always needs new challenges to meet and new horizons to reach; space is such a 'New Frontier'. Space has always been a source of inspiration, of knowledge and of dreams. The basic questions raised by space programmes are particularly appealing to young people, often encouraging them to become scientists and engineers. Space is also a living laboratory where the products and resources that will contribute to the progress of humanity can be tested.

8413

young Europeans completed the complex application process to become European astronauts.

Many more

demonstrated their interest in space exploration, but didn't finalise the process leading to completing the entire application.

SPACE LEADS TO SCIENTIFIC EXCELLENCE

Space programmes nourish the scientific community and provide it with new perspectives. Thanks to this, Europe is a recognised leader in key areas, including solar–terrestrial physics, planetary science, and infrared and X-ray astronomy. For example, ESA's Planck mission is looking back into the origins of the Universe, observing the background radiation released by the Big Bang itself, about 14 billion years ago.

By supporting scientific laboratories across Europe, space programmes prevent 'brain drain', the loss of talented individuals to other continents. Space activities also sustain the quality of university science courses. Students working on space missions often go on to careers in industry or science or even business, fortified by the exceptional experiences of time-sensitive, cutting-edge, multinational projects.

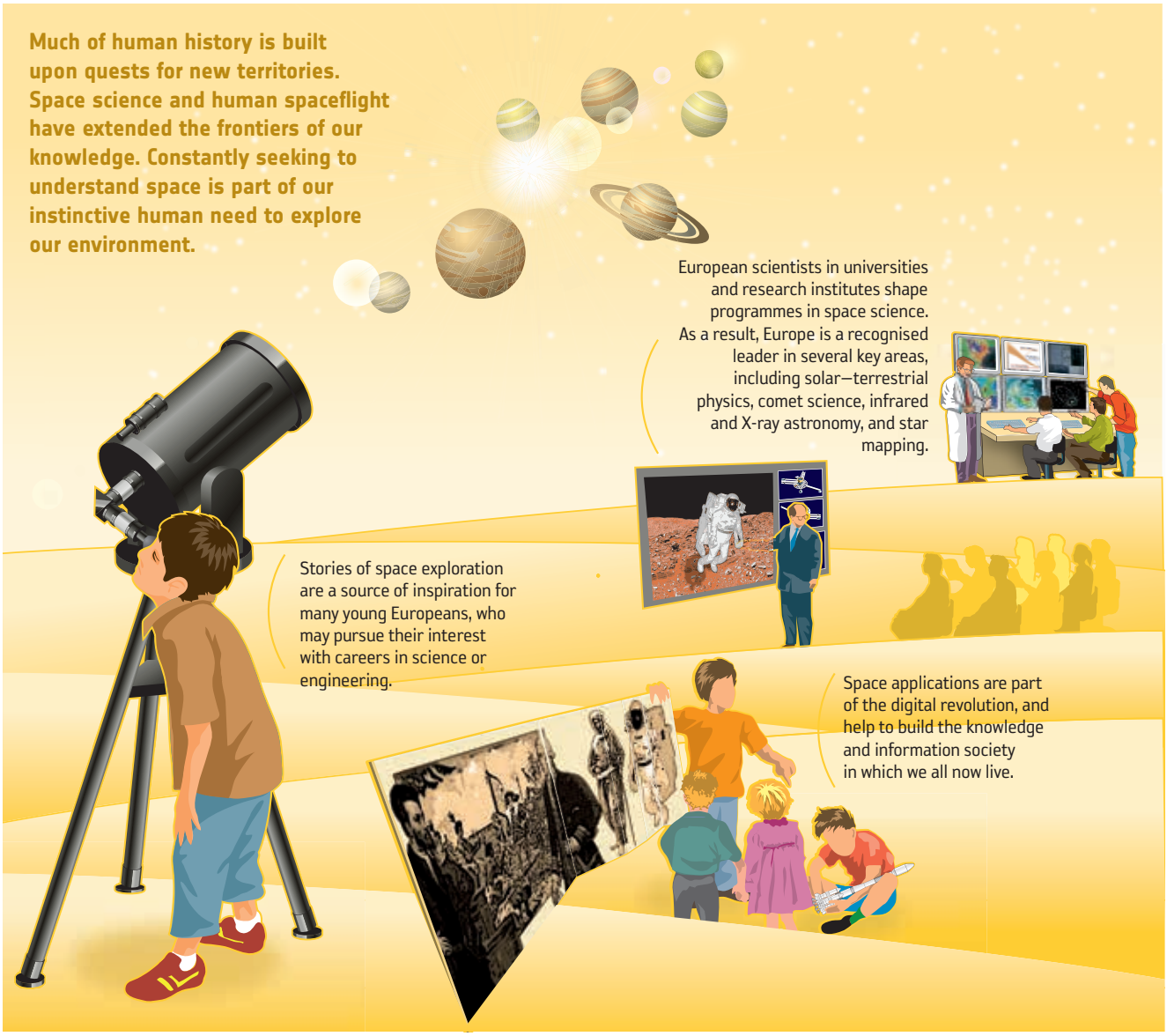
ADDING VALUE

The unique technological requirements of space programmes often lead to technology leaps in high value-added fields. The demands of space missions have led, for example, to the development of ultra-sensitive accelerometers, devices that detect inclination, vibration and shock. In space, accelerometers are a vital piece of navigational systems; back on Earth, they improve many different systems such as smartphones. Optics, robotics, electronics, energy generation, propulsion systems and software solutions are enriched with technology originally developed for space.

THE NEW FRONTIER

Space science and human spaceflight push back the frontiers of knowledge and answer our need to explore the natural environment. Space exploration feeds the dreams generated by the Universe.

→ SPACE: THE NEXT FRONTIER



Europe is playing an important role in the international exploration of Mars. As a next step, a mission to find out whether there are traces of past or present life on Mars is being prepared.

SPACE TURNS YOUNG PEOPLE ON TO SCIENCE

Missions to Mars and similar exciting ventures continue to be an inspiration to many young Europeans. Studies have shown that, when asked if they would like to work in science and engineering, a majority of young people across Europe say 'no' – particularly girls and young women. Interestingly, the same young Europeans say 'yes' when asked if they are interested in 'rockets, satellites and space travel'. Space activities are an excellent way to grab the attention of the scientific thinkers and leaders of tomorrow.

Is there life on Mars?

→ SPACE: A MULTIPLIER FOR ECONOMIC GROWTH AND A EUROPEAN SUCCESS STORY

Large events such as the Olympic Games would not be global events without satellite communications. Over 700 million people watched the 2010 football world cup live and 4.3 billion people had home access to dedicated Beijing 2008 coverage. Satellite services reach every corner of the world and its economic impact spreads far downstream into every office, home and even vehicle. Like water or energy distribution infrastructures, space systems and applications are becoming so embedded in our modern societies that their benefits go largely unnoticed, except when systems fail to work.

If all satellites were to be switched off for only one day many things we are used to would not work: for instance, the weather forecast for three days ahead and many other TV transmissions would be lost; planes and ships would be grounded without weather prediction and navigation on their routes; millions of car drivers would be lost in cities and roads; long-distance telephone calls would be cut; broadband Internet connections in many areas would be dropped… It would be total chaos.

Europe represents about

10%

of global public space investment but European industry is highly competitive and has captured

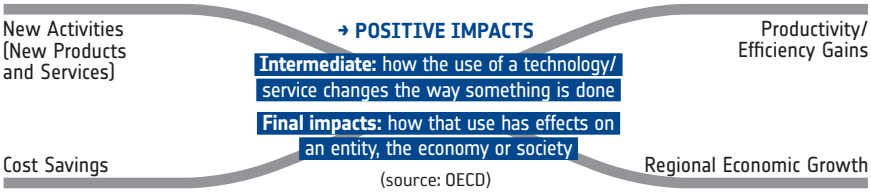
40–50%

of the global commercial market in telecommunications satellites and launch services.

Europe has two of the three largest worldwide satellite communications capacity providers (SES Astra and Eutelsat) and the most successful launch service provider (Arianespace). It has created the successful weather monitoring satellite operator Eumetsat and helped to create the mobile communications provider Inmarsat.

WHAT TYPE OF RETURN ON INVESTMENT?

Public sector investment in space systems is driven by a number of motives, such as improving R&D and scientific capacities, developing independent access to space and security capabilities and seeking profitable new markets for national commercial firms. Socio-economic impacts are often not a primary objective, but positive effects already occur during the course of the investment and contribute to the global competitiveness of a region and/or a country.



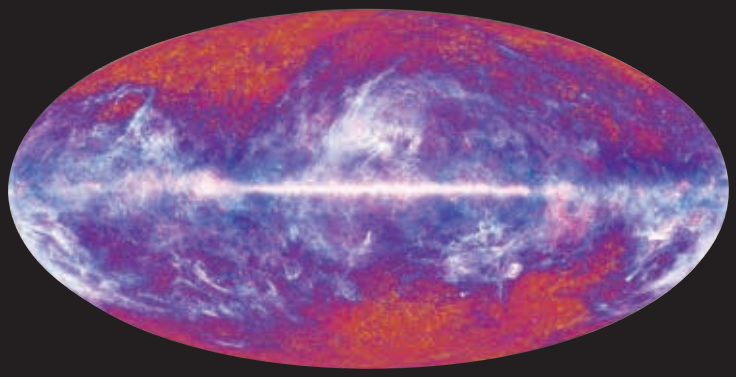
In addition, institutional space programmes are largely contracted out to industry, with a multiplier effect in terms of industrial turnover. National studies have shown that each €1 million contributed to the European Space Agency generates a turnover of around €4 million via new market development.

ENABLING SUBSTANTIAL COST-SAVINGS

Quasi-realtime space data integrated into computerised models have significantly improved the value of weather forecasting information, significantly reducing errors in hurricane forecasts and giving more time to warn populations and businesses. Data coming from Earth observation satellites support agricultural forecasting. The ability to predict crop production, yield and quality reliably is key for economic planning and commodities forecasting and improving global food security. Satellite navigation and tracking systems contribute to the huge advances in the efficiency of transport systems by road, sea, rail and air. They enable the operations of the global financial system through synchronised money movements, as well as individual transactions via ATMs.

→ SPACE: UNDERSTANDING OUR UNIVERSE AS WELL AS OUR HOME PLANET

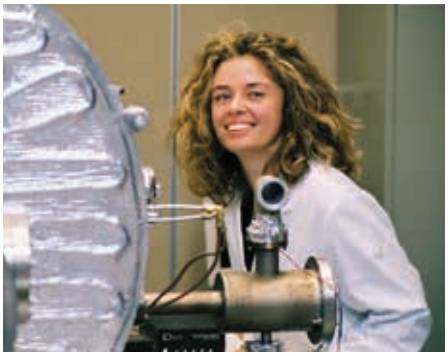
Space systems allow humans to answer many questions on the creation of the Universe and the origin of life in it, its evolution and its possible future. Europe's Planck mission is not only providing new insight into the way stars and galaxies form but is also telling humankind much about how the Universe itself came to life after the Big Bang.



Space allows us to keep close watch on our home planet. Thanks to its satellites, Europe measures sea-level changes and surface temperatures, observes seasonal growth of plankton and detects variations in the thickness of the Greenland and Antarctic ice sheets. Thinning of the stratospheric ozone layer, first conspicuous as a 'hole' over Antarctica, is now apparent also in the Northern Hemisphere, and has been measured via European satellites since 1995.

TACKLING SOCIETAL CHALLENGES

Space investments contribute to the management of the long-term challenges of the 21st century. The Relevance of Science Education (ROSE) study shows that space attracts the interest of all young people in the world, irrespective of their origin or social situation, and can be therefore a major tool to bring young people to science and technology studies in general. By serving space science laboratories and astronomical institutes across Europe, European space initiatives contribute to reducing the brain drain of talented individuals to other continents and to sustaining the quality of university teaching in scientific disciplines.
Advanced energy systems for space missions must be fully renewable, reliable and highly efficient and thus may have spin-offs to meet similar terrestrial concerns. In addition, space services contribute to the management of energy production and distribution grids.



A new generation of broadband satellites (Hylas, Ka-Sat) provide broadband Internet across Europe, delivering access to rural areas as well.
New satellites will be deployed to meet the needs of mobile users across the globe, providing broadband communications with ships, planes and professional users, such as TV and oil companies.

- In Europe about

30 000 people

work directly for the space industry and

ten times

that number when including employment in downstream sectors linked to space, such as satellite operations, satellite services and value-adding services.

- Revenues generated by institutional investments in space over a decade have led to a

multiplier effect of

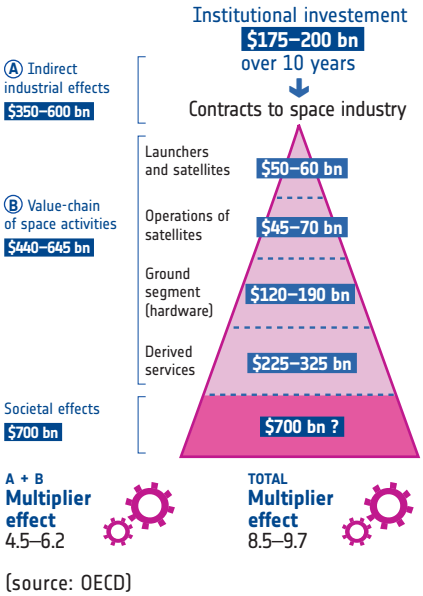
between

4.5 and **6.2**

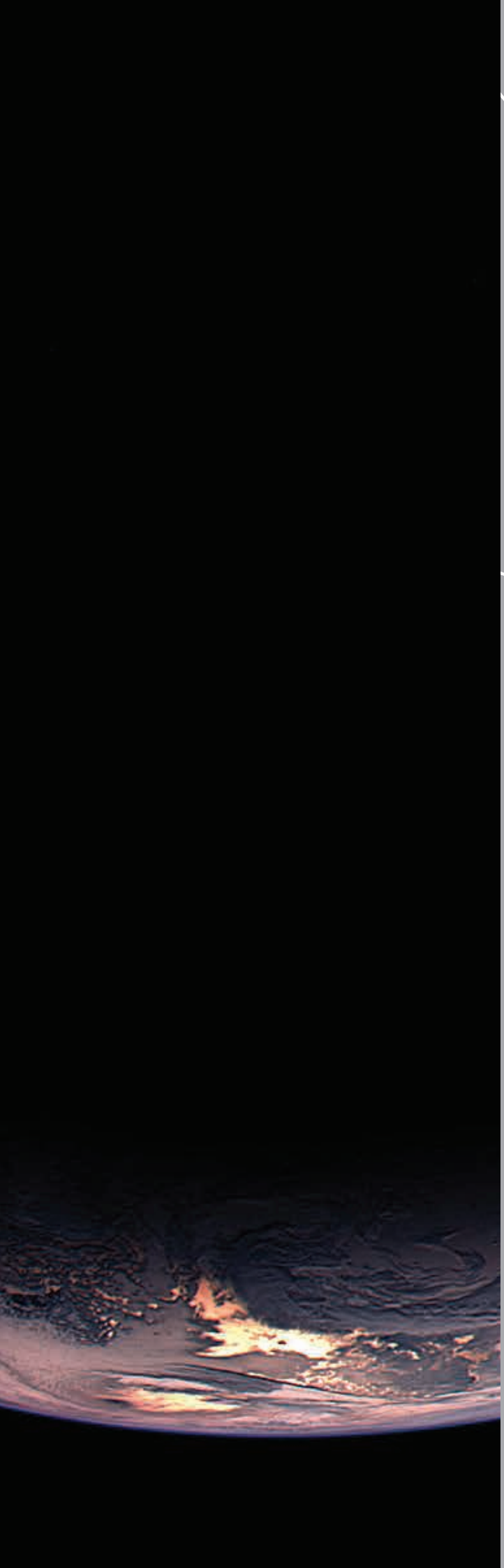
when considering the value chain and indirect effects only, and between

8.5 and **9.7**

when including the societal effects



(source: OECD)



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