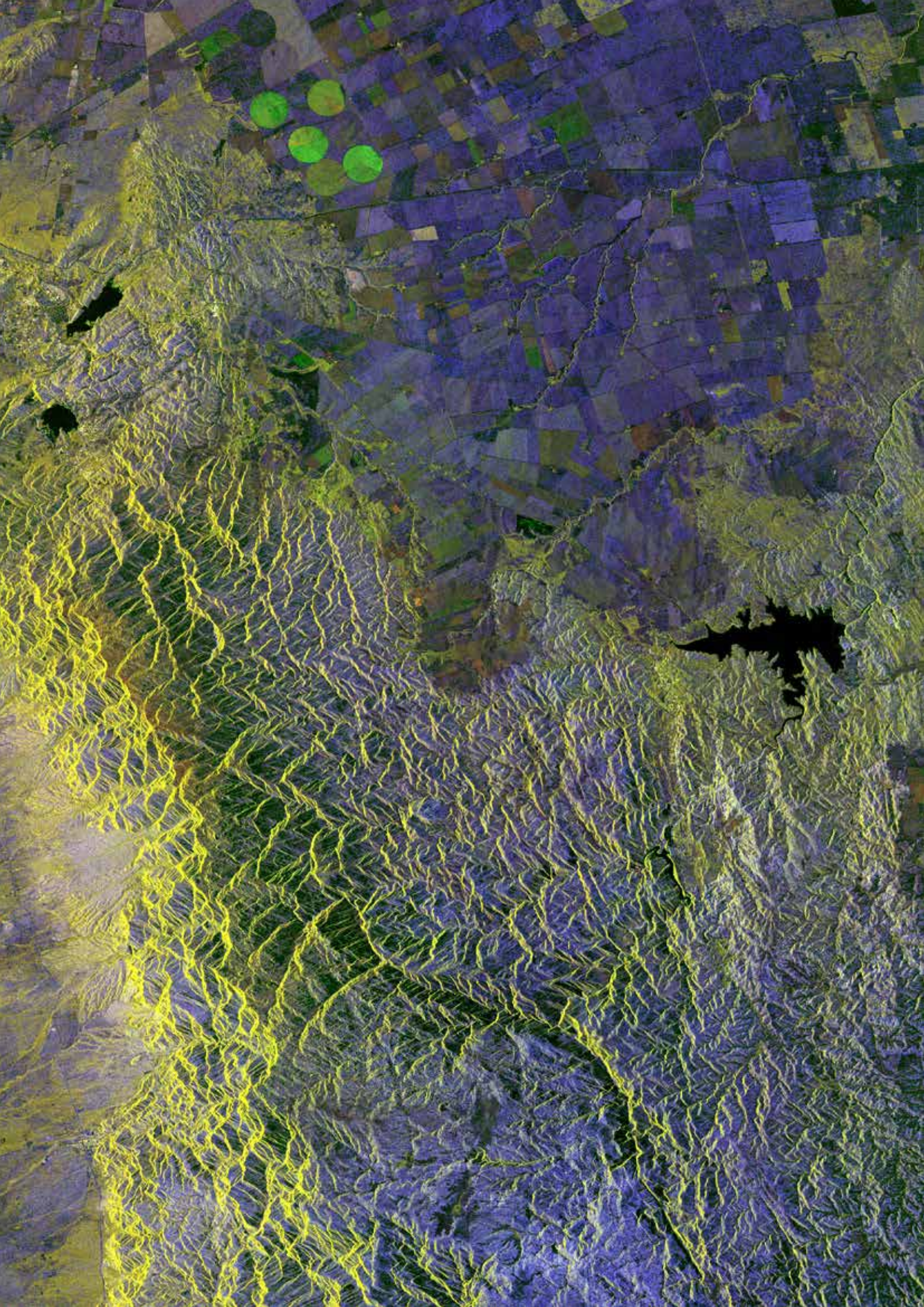


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Innovation for sustainable development



The sources and pathways of innovation

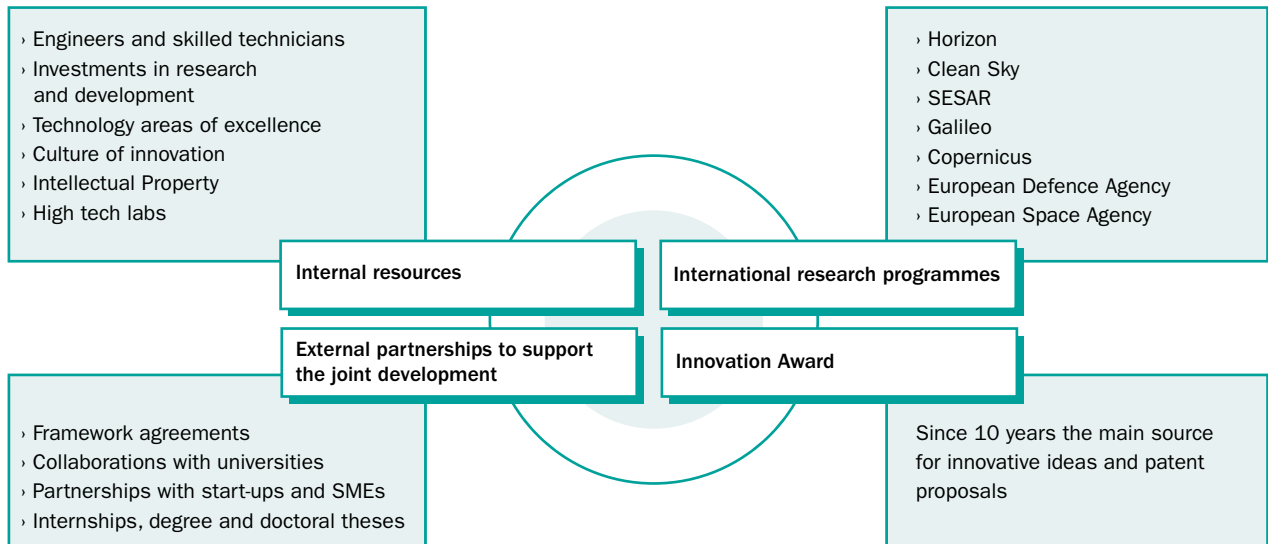
Leonardo pays the utmost attention on enhancing the creativity of its resources and facilitating the continuous sharing and ongoing circulation of knowledge within the Group.

Sharing the culture of innovation involves an extended network comprised of international universities, institutes and research centres, customers, suppliers and start-ups, according to the open-innovation model.

In conjunction with the vision and the goals of institutional stakeholders and the European technological roadmap, Leonardo is partner of excellence in national or European-funded projects which ensure the resources necessary for research and subsequently for implementing the derived innovation.

The EU Framework Programme for Research and Innovation Horizon 2020 is the key tool for reaching the goals set in the Europe 2020 Strategy, for a smart, sustainable growth via an economy developed based on knowledge and innovation.

THE OPEN INNOVATION MODEL



LEONARDO AS THE MADE-IN-ITALY SOURCE OF INNOVATION

In 2016, Leonardo was awarded the National Innovation Award, the most prestigious Italian prize dedicated to innovation Made in Italy, conferred at the presence of the President of the Italian Republic, thanks to a project that prevents the risk of in air collisions between manned and unmanned aircraft and that ensures the safety of the civil airspace.

Unmanned aircrafts represent the new business frontier of the Aerospace, Defence and Security. In this respect, Leonardo has a wide range of technologies. The full safety of their use and the overcoming of the current flight restrictions to separate “corridors” are fundamental to enable their integration into the airspace and to develop a sector that can offer many business and technological development opportunities to Italy.

In 2016, Leonardo also received an award for its “3D real-time acoustical imaging system”, a project that is part of the National operational programme for the preservation of underwater heritage. This system may have different applications in both the civil sector (exploring and maintaining underwater archaeological findings or inspecting underwater tunnels) and the military sector (detecting underwater explosives).

INNOVATION OF LEONARDO IN BRIEF

Internal resources

- › Approximately 11,000 engineers
- › Approximately 13,000 specialised technicians

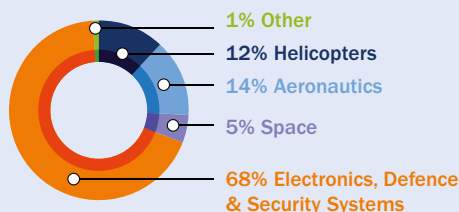
Key technologies

- › Software
- › Materials
- › Electronics
- › Optronics
- › Mechanics
- › Modelling and simulation
- › Systems design
- › Systems autonomy
- › Communication and cyber security

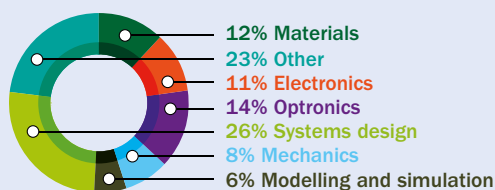
Intellectual Property Value Management

- › Diversified patent portfolio with a Compound Annual Growth Rate (CAGR) of 6.4% since 2006

BREAKDOWN OF PATENTS BY SECTOR



BREAKDOWN OF PATENTS BY KEY TECHNOLOGY



Investments in research and development

- › €1.4 billion invested in R&D, ~11% of revenues
- › Leonardo is the fourth company in Italy, the fifth in the A&D sector and the 99th in the world (top 100)⁸

Main collaborations with universities in 2016

The Turin Polytechnic, the Milan Polytechnic, Sapienza University of Rome, Bologna, Pisa, Genoa, L'Aquila, Trento, Federico II of Naples, Sant'Anna di Pisa, the National Council for Research, the National Institute of Astrophysics, the National Institute of Geophysics and Vulcanology, Edinburgh, Glasgow, Bristol, Heriot-Watt, Chapman University, University of Rochester, Rice University, University of Delaware, University of California San Diego, Lublin University of Technology, Warsaw University of Technology, Rzesów, Nanyang Technological University (NTU) of Singapore

Tools to spread the culture of innovation

POLARIS INNOVATION JOURNAL Quarterly journal focused on the technological developments in the company and the academic and scientific fields. In its seventh year of activity, for a total of 28 issues, in 2016 this journal featured more than 380 articles by over 1,400 authors, of which approximately 200 were not part of the company.

POLARIS PAPERBACKS Half-year monographs focused on specific technological matters related to innovation. Since its launch in 2015 to date, five paperbacks have been published, covering sustainability, intangible capital, software, UAV/RPAS and emerging technologies.

LUNCHTIME SEMINAR Short product or technology presentations held during lunch break. In 2016, 52 seminars were held, attended by over 6,000 participants in Europe.

In the United States, Leonardo DRS's Lunch & Learn numbered 12 in 2016.

8. The 2016 EU Industrial R&D Investment Scoreboard.

The roadmap of technological development

In order to effectively direct and focus its efforts into investments in research and development, Leonardo has evaluated the most significant innovation issues with an impact on technologies over the next ten years.

The analysis shows an updated vision of the technological trends of the Aerospace, Defence and Security sector, in addition to a perspective on the current technological situation of Leonardo and to the development priorities based on the future and open to the external environment.

The potential economic impact, the market requirements, the enabling technologies and the possible applications to current and future products have been identified for each aspect. In addition to this, the approach to acquire/develop and deploy technologies has been identified to ensure and maximise market return and business impact.

As part of its technological roadmap, Leonardo identified approximately 80 innovative technological aspects related to 15 different areas.

Management of these aspects will result in technological solutions or enablers for the future development of products as well as technological applications which can already be applied to the existing products. The main areas of interest about the new manufacturing processes and technologies are the advanced materials, Industry 4.0- and energy efficiency-related technologies, cyber security and platform autonomy technologies.

TELESPAZIO, A TV SUSTAINABLE INNOVATOR

As part of Eutelsat's Broadcast Seminar 2016, Telespazio and Sky Italia received an award as TV best innovators for having integrated a new solid state amplification technology for DBS (Direct Broadcasting Satellite) frequencies in Sky Italia's uplink systems, for the first time in the world.

This solution increases the reliability and operating efficiency of transmission systems while reducing CO₂ emissions and operating costs.

THE PUMA T4 - LTE AT THE INTERNATIONAL CRITICAL COMMUNICATIONS AWARDS (ICCA)

The innovative solution, which received the Best Innovation Award, has been developed by the Security & Information Systems Division and combines, for the first time, all safety features of TETRA (TErrestrial Trunked RAdio) with the new broadband LTE technology.

It is a professional telephone that offers the same usability of a common smartphone while maintaining all the safety features necessary for those operating critical communication systems.

THE ASTYANAX PROJECT AWARDED IN POLAND

The Polish Ministry of Defence awarded ASTYANAX project of Leonardo the second prize of the prestigious "Competition for the best scientific work and implementation in the area of defence". The project was carried out in collaboration with Polish and Spanish partners and focused on the development of a Structural Health Monitoring (SHM) methodology for fixed-wing and rotary-wing aircraft.

The Innovation Award

The ever growing number of participants confirms the success of the Innovation Award: in twelve years, over 9,000 technology innovation projects were submitted, involving more than 25,000 employees of every sector of Leonardo.

Innovation is a fundamental lever that drives the way to make business at Leonardo, constantly committed to enhancing and developing a unique and priceless wealth of knowledge which is cultivated with passion and determination. In this context, for over ten years, the Innovation Award has involved the Group' employees from all over the world including, for the second year in row, universities, in discussing the technological challenges of the future.

In 2016, Leonardo employees in Italy, the United Kingdom and the rest of the world submitted almost 700 projects. Students, newly graduates and post-graduate students of scientific disciplines from Italian universities participated, generating approximately 5,000 contacts on the specific online platform. Most of the successful projects have as common element the attention to environmental sustainability.

WINNING EMPLOYEES PROJECTS OF THE 2016 INNOVATION AWARD

Incremental innovation

Passive infrared system, hence that cannot be intercepted, to identify and trace targets (missile/naval/air) for naval frigates.

ADVANTAGES Sensor integration for constant 360° ship monitoring and immediate detection of the distance of possible threats.

Idea

Protective films in nano-composite material with graphene particles with superficial extension.

ADVANTAGES Prevents the intrusion of substances such as water or organic solvents in the composite structures, which reduce the properties or not permit the use for the structural applications.

Radical innovation

X and Ka bi-band antenna for radar applications developed for radar sensors used to control targeting naval systems which, otherwise, would use two separate antennas, one for each frequency.

ADVANTAGES Improved performance and reduced operating costs.

Best patent

Ground-air-ground unified communication system that uses the VHF data link mode 2 technology to integrate and optimise the various telecommunication networks used by the companies that operate air traffic control services.

ADVANTAGES Overcoming the telecommunication limits between control tower and aircraft, when these are managed by different operators.

LEONARDO AND THE POLYTECHNIC OF MILAN: A STEP FORWARD IN OPEN INNOVATION

The first project launched by Leonardo in collaboration with the Polytechnic of Milan is aimed at designing and building prototypes of devices to reduce noise and vibration both inside and outside the helicopter cabin.

Research, development, innovation and training activities are at the heart of the Innovation Hub project, in relation to which Leonardo and the Milan Polytechnic entered into a framework agreement for shared projects to create synergies between the Polytechnic and the Group.

The agreement initially covers nine technological areas: fluid-aerodynamics; structures and structural and multifunctional materials; mechanical and electrical systems; avionic components and systems; guidance, navigation and control electronic systems; software engineering; system engineering; audible and visible sensors; space robotics. In addition to this, collaborations will be forged for professional and management training.

WINNING UNIVERSITY PROJECTS

FIRST PRIZE TO POST GRADUATES

Solar-battery integration with photopolymers

Using innovative materials to develop devices that integrate photovoltaic power generation with the battery storage.

ADVANTAGES Photopolymers that, unlike those produced using industrial processes which entail a high environmental impact (high temperatures, use of chemicals or solvents), can be obtained through processes that only require a light source.

SECOND PRIZE TO POST GRADUATES

TIGRE: Tastiera GeneRa Energia (Energy generating keyboard)

Energy is recovered by converting the mechanical energy used to press the keys of a PC keyboard into electrical energy.

ADVANTAGES Through piezoelectric transducers, materials which can generate a voltage difference when subjected to mechanical strain, the keyboard can use the energy generated by the finger pressure to contribute to its own feeding.

THIRD PRIZE TO POST GRADUATES

Synthesis of carbon and silicon nanostructured materials for electrodes optimised for lithium batteries

Development of innovative electrodes using carbon and silicon nanostructures.

ADVANTAGES These electrodes improve electrical conductivity and the efficiency/life of batteries.

FIRST PRIZE TO STUDENTS/NEW GRADUATES

Low switching loss converter to feed high-speed 3-phase electric motors for aerospace applications

Low switching loss converter of electric power alternative to SiC (Silicon Carbide) MOSFET inverters.

ADVANTAGES Multidisciplinary application, of potential great interest for more/all electric vehicles.

SECOND PRIZE TO STUDENTS/NEW GRADUATES

Optimisation of the titanium alloy rotating parts' post-machining process

Study of the technical feasibility of a process concerning the final stage of mechanical processing, fully automated through the use of anthropomorphic robots.

ADVANTAGES Reduced production time, reduced spare parts inventory time, improved quality of product surface and reduction/elimination of defects in materials.

THIRD PRIZE TO STUDENTS/NEW GRADUATES

Energy Harvesting through magnetostrictive materials

Harvesting of electrical energy from the mechanical energy which would otherwise be lost to the environment, by using magnetostrictive materials.

ADVANTAGES Applications related to environmental sustainability and energy saving.

LEONARDO REWARDS ITALIAN EXCELLENCE

Leonardo financed a prize of the Leonardo Committee that promotes Italian economy, culture, science, technology and top quality products. In 2016, the Committee awarded the best degree thesis on the “Made in Italy” excellence in several sectors. The prize was awarded to a new graduate in aerospace engineering from the Milan Polytechnic for his degree thesis on an algorithm to protect against space debris. The degree thesis proposes the implementation of an algorithm that can estimate the position, speed, configuration and inertia properties of unknown objects which may collide against unmanned space vehicles, by processing the data provided by two cameras placed in stereoscopic set-up on the above vehicles.

Approximately 30,000 large space debris surround the earth resulting from disused satellites, rocket parts and objects lost by the astronauts during their missions.

INNOVATION HUB AT UK SITES

The Maker Space of Luton, inaugurated in June, and the Edinburgh Innovation Hub, opened in November, are areas at Leonardo available to all employees to explore innovative ideas. Employees enjoy free access to the Internet, information, tools and “making” resources (3D printers, Raspberry Pi kits, Software Defined Radio, 3D scanners, oscilloscopes and portable spectrum analyser) and can work on the “rapid prototyping”.

All this facilitates a “can do” approach, disseminating and sharing skills, experience and plans that may turn into real business opportunities.

The members of the Fit For the Future (FFF) team of the Maker Space organised a series of preliminary workshops to the use of the devices, in addition to a series of exercises developed by Technical Fellows.

TOGETHER TO SPEED UP INNOVATION PROCESSES

Over 140 companies participated in the first edition of “PoliTo Techshare Day”, with approximately 300 “one to one” meetings between inventors and companies.

PoliTo and Leonardo made available to SMEs 26 and 9 patents, respectively.

Leonardo played a central role in the first edition of the “PoliTo Techshare Day”, an event organised by the Turin Polytechnic to strengthen the collaboration between universities, big companies and small and medium companies (SMEs).

Companies analysed the specifics of the patents made available online through a dedicated platform, and subsequently discussed the advantages and the possible application of technologies directly with the inventors. With this initiative, for the first time in Italy, the offer of industrial patents was in direct contact with demand for innovation of SMEs.

The patents made available by Leonardo include that related to the self-repairing composite material, also at low temperatures, that for recycling prepreg-scrap and that related to a surveillance system of an area crossed by people.

THE INNOVATION BOOST FROM START-UPS

This programme received 61 applications, of which 90% from people under 40, mainly related to advanced applications in ICT and Industry 4.0, systems and advanced systems for the safety of individuals and health systems and infrastructures.

Leonardo is one of the founding members of *Fondazione Ricerca ed Imprenditorialità* (Foundation Research & Entrepreneurship), a project launched and promoted jointly by four components of the innovation ecosystem: the scientific/academic world, industry, banks and institutions.

In 2016, Leonardo promoted the “*Programma Sviluppo Startup & PMI Innovative*” (Programme for the development of innovative start-ups and SMEs), which is aimed at developing start-ups by accelerating business projects and businesses already in place that intend to scale up their operations.

The 10 successful proposals joined the Foundation’s technological acceleration programme, which is aimed at providing knowledge and management skills in the preparation of the related business/industrial plan.

Contribution of Leonardo to sustainable development

In a global scenario where the challenges of the industry are increasingly revealing themselves, Leonardo works to interpret the needs of a fast-changing market and provide the most effective answers to the growing issues related to safety, efficiency in the use of natural resources and reduction of the environmental impacts.

THE PLANET'S LIFE AND RESOURCES

Through the COSMO-SkyMed system, Leonardo is committed to developing earth observation activities, the "new frontier" of space economy, in order to monitor terrestrial and marine ecosystems, ensure the sustainable management of natural resources and support rescue operations for victims of earthquakes and natural events.

THE NEED FOR SECURITY

Thanks to the dual-exploitation of its technologies, Leonardo is a leader in the systems and solutions for the resilience of critical infrastructures, ports and airports, and in monitoring the flow of people and goods, specifically in highly populated urban areas, where the need to feel safe from threats, including terrorist attacks, is stronger.

THE MOBILITY SOLUTIONS OF THE FUTURE

Thanks to its participation in the European Clean Sky and SESAR aerospace programmes, Leonardo is developing solutions that improve the sustainability of the air traffic of the future, assisting the entire sector in meeting the stringent abatement objectives concerning its CO₂ emissions.

DIGITALISATION PROCESSES

Thanks to the experience gained in the fields of communication, networking, cyber security and cyber intelligence, Leonardo provides the most effective solutions against IT threats, the economic and social development introduced by the industrial revolution 4.0 and the exponential growth of Internet of Things.

LEONARDO FIGHTING CLIMATE CHANGE⁹

The Paris Agreement and the conclusions of the COP22 in Marrakesh clearly indicated the degree of awareness reached in relation to the average global temperature increase and the higher reactivity of the international community compared to the past in confirming a less carbon intensive economic development strategy.

Thanks to the invitation to participate in the "Fighting Climate Change: Sharing Italy's Innovative Technologies" conference, organised by the Italian Permanent Representation at the United Nations in New York, Leonardo unveiled its technological and application solutions to tackle and prevent the harmful effects of climate change to the international community.

The NASA and US Federal Agency for Meteorology (National Oceanic and Atmospheric Administration - NOAA) confirmed that 2016 was the hottest year since 1880.

The satellite systems, a sector in which Leonardo has been at the forefront for over 30 years, enable accurate measurements of global changes.

LEONARDO FOR SUSTAINABLE TELECOMMUNICATIONS¹⁰

Leonardo is among the new members of the 5G IA (5G Industry Association), which is the industrial counterpart of the European Commission in the 5GPPP (5G Public Private Partnership).

The 5G IA puts forward the evolution strategies for the fifth generation of networks, defining with the European Commission the main technical and experimental issues to be pursued, including through European financing.

9. www.nasa.gov.

10. <https://5g-ppp.eu/>.

The goals of the 5G networks are:

- › increasing wireless capacity by 1,000 times on 2010;
- › connecting 7 trillion wireless devices with a catchment area of 7 billion people;
- › reducing energy consumption by 90%.

Most of the main targets of the new 5G networks are related to sustainability issues, including the reduction in network and terminal consumption, the optimisation of the use of the electromagnetic spectrum, and some vertical applications of new technologies, defined as part of the “Critical Communications” field, such as telemedicine, energy, public safety and monitoring of large areas.

Earth care and sustainability in the use of resources

The studies and research carried out on this issue show that 70% of the forest habitat is eroded or fragmented, with significant impacts on biodiversity.

In its most recent report on the state of world fisheries and aquaculture, the FAO indicates that almost one third of fish stocks is caught at a biologically unsustainable pace.

The FLEX mission of the European Space Agency will collaborate with Copernicus’ Sentinel-3 satellite on which the SLSTR radiometer, another tool developed by Leonardo, measures the surface temperature of land and oceans.

Thanks to the contract won in Brazil, Leonardo will monitor one million square kilometres in the Amazon area to fight deforestation.

Through Telespazio and e-Geos, Leonardo processes the combined information obtained from satellites, aircraft and unmanned aircraft for precision farming purposes. Measuring soil humidity and plant energy status allows the optimisation of irrigation, fertilisation and plant health treatments, contributing to the improvement of the consistency and quality of agricultural, foodstuff and forestry production.

Furthermore, oil spills can be monitored using radar satellite data which also enable the identification of the ships that may have caused them. The prompt identification of oil spills triggers the activation of containment and recovery measures, limiting the environmental damage. Again with respect to the marine sector, satellite technologies are being increasingly used to fight illegal fishing that, every year, withdraws valuable food resources from the planet¹¹.

Starting from 2022, the FLEX mission, which is part of the Earth Explorer programme supported by the European Space Agency (ESA), will open new frontiers in monitoring the health of vegetation, a fundamental element of ecosystems, which are essential for maintaining life on this planet. Leonardo will head a consortium of European industries to construct a spectrometer which, from an altitude of approximately 800 km and with absolute precision, will measure the fluorescence intensity, that is the faint reddish glow during chlorophyll photosynthesis invisible to the bare eye, which is a direct indicator of the health of vegetation. Indeed, the information about the health and the stress of the planet’s vegetation is important, given people’s increasing demand for the production of food for animals.

PROTECTING THE AMAZON RAINFOREST, OUR PLANET’S GREEN LUNG

Every year, forests globally absorb 2.4 billion tonnes of organic carbon with Amazon absorbing about a quarter of it. Through e-GEOS, Leonardo won the contract with the Brazilian-based Geoambiente called by the Amazon surveillance system centre (CENSIPAN) for the monthly acquisition of satellite data relating to about a 1 million square kilometres of the Amazon area to monitor deforestation. The radar sensors onboard satellites will provide ongoing monitoring, day and night and under all weather conditions,

11. FAO, The State of World Fisheries and Aquaculture, 2016.

representing the best solution for this area which shows frequent rains and constant cloudiness for most part of the year.

THE LARGEST PHOTOVOLTAIC GENERATOR IN THE HISTORY OF SPACE EXPLORATION ON THE JUICE PROBE

The ten panels to be built for the JUICE (Jupiter Icy Moon Explorer) mission, for a total surface of 97 square metres, will equip the largest generator in the history of the solar system exploration. This is a new record for Leonardo, which follows that of the supply of similar systems for many space missions, including Rosetta, whose 64-square meter solar panels currently hold the world record.

The Gallium Arsenide (GaAs) solar cell technology will be applied to the generator panels. This is a crystal that converts sunlight into electrical power with a yield per square meter that is almost twice that of the solar panels for terrestrial use. Solar cells can power the probe also when the sunlight, due to the great distance, will be less than a twenty-fifth of that reaching the earth and the solar panel will be exposed to a temperature of -230 °C.

Thanks to the study of materials and processes, Leonardo technology can operate in extreme conditions of temperature, radiation and the vacuum of space, ensuring energy autonomy to space missions throughout their useful life.

SUSTAINABLE DEVELOPMENT IN THE RESOURCES OF THE ARCTIC REGION

The Arctic region, one of the least accessible areas of the planet, may offer a new potential for the development and exploitation of energy resources, while tackling the issue of risk mitigation for the natural and human environment associated with these activities.

During the “Arctic council and Italy’s perspective” meeting organised by the Ministry of Foreign Affairs and Cooperation, in collaboration with the Institute for International Affairs, the National Research Council (CNR) and the Italian Society for International Organisation (SIOI), Leonardo unveiled its wealth of innovative solutions to tackle the challenges posed to the sustainable development of the region: environmental monitoring, safety of indigenous people and seaworthiness of Arctic routes.

More than sixty satellites and probes have been launched between the 90s and today and they operate in space thanks to the photovoltaic technology of Leonardo.

Using this highly-efficient technology, solar panels have become smaller and lighter, which represent a key competitive factor.

Every year, Leonardo integrates over 50,000 solar cells.

Sustainable mobility

Over the next few years, more people will fly than today, especially in emerging economies where the demographic growth is more marked. The design and construction of new aircraft and solutions shall meet the market's growing demand and optimise traffic volumes also in terms of sustainability.

The International Air Transportation Association (IATA) forecasts that the current 3.8 billion air transport passengers will double by 2035, with an average annual increase of 3.7%.

Europe is facing these sustainability challenges with ambitious aircraft programmes, of which Leonardo is the founding partner and leader in many areas. Specifically, Leonardo is currently implementing the demonstration phase, with in-flight and on-ground tests, of key technologies for the realisation of more efficient and more environmentally-friendly regional helicopters and aircraft.

ROLE OF LEONARDO IN EUROPEAN AIRCRAFT PROGRAMMES

	Development	Targets and benefits
Clean Sky	Technologies to improve helicopters' efficiency	ACTIVE ROTORS - Cutting vibrations by 90% and abating noise by six decibels. Improving performance of the rotor by between 3% and 5% THERMOPLASTIC ROOF PANEL - Cutting costs, weight and maintenance costs ELECTRIC TAIL ROTOR DRIVE - Improve flight and cruise performance by changing rotor speeds
	Development of "green" aircraft for regional traffic	GREEN REGIONAL AIRCRAFT - Reducing the product's environmental impact over the entire life cycle, from the design stage to the withdrawal of the aircraft from the market and the recycling of components. In July 2015 first demonstrator flew on an ATR 72 equipped with a multi-functional panel developed in the frame of Clean Sky ECODESIGN - Developing the Liquid Resin Infusion technology to produce monolithic wing structures in composite material and the process to recycle cured composite materials, reducing the environmental impact on the product's entire life cycle by more than 80%
Clean Sky 2	Demonstration of enabling technologies for a next-generation civil tilt-rotor aircraft, which can operate as both a helicopter and an aircraft	ADVANCED ENGINE INSTALLATION AND DRIVE SYSTEM - Reducing air resistance and emissions during advanced flight ADVANCED TILTING WING - Increasing the rotor's efficiency when hovering and decreasing consumption during cruise flight (CO ₂ : down by an overall 17%) ADVANCED PROROTORS AND FLIGHT CONTROLS - Cutting the noise impact during critical flight phases by abating noise and optimising flight paths (-7%, -3 decibels overall) ADVANCED MATERIAL AND PROCESSES FOR DRIVETRAIN COMPONENTS - Eliminating harmful products from processing. Reducing the energy impact by integrating ALM (Additive Layer Manufacturing) processes for structural elements, decreasing the buy-to-fly ratio. Cutting maintenance expense and the related operational impact by using advanced materials for parts subject to wear
	Development of "green" aircraft for regional traffic	Developing, integrating and validating advanced technologies for future application on aircraft with the objective to reduce the environmental impact, while increasing industrial competitiveness
SESAR and SESAR 2020 (Single European Sky ATM Research)	Upgrading the European Air Traffic Management (ATM) system	Managing up to three times the current air traffic, while cutting costs by 50%, increasing flight safety by a 10 factor and contributing to the 10% reduction of the environmental impact for each flight (reducing fuel consumption, noise and emissions) The first stage of research and development (SESAR 1) was completed at the end of 2016. The next phase, SESAR 2020, started at the end of 2016 and will end in 2021

In civil aviation, in October 2016, the International Civil Aviation Organisation (ICAO) agreed a Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) whose aim is to integrate the measures that the air transport industry is already implementing to cut CO₂ emissions, with technical and operational improvements and developments for the production and use of sustainable alternative fuels for aviation. Leonardo collaborated with ICAO by sending its specialists to several international bodies (including the Montreal offices) to support Italy's National Civil Aviation Agency (*Ente Nazionale Aviazione Civile* - ENAC).

THE ECO-EFFICIENCY OF AEROSTRUCTURES FOR COMMERCIAL PLANES

New models of planes are progressively enriching the commercial aircraft sector with more sophisticated technical solutions, often developed for military platforms. With respect to materials, over the past few years, composites have been increasingly used in commercial programmes thanks to the possibility of significantly reducing the weight of the aircraft. Leonardo Aerostructures Division is a partner of Boeing in the 787 programme producing approximately 14% of the aerostructure in carbon fibre. Leonardo and Boeing have developed and integrated the one-piece-barrel technology in the production of aircraft fuselage, where fuselage sections are produced as single pieces, reducing the number of parts and assembly times as well as the related costs by 15-20%.

The potential weight reduction due to the use of composites in the aerostructures generates:

- › savings in fuel consumption (approximately 10-15%);
- › reduced CO₂ emissions (approximately 20%).

MAINTENANCE AND LIFE - Composites are extremely resistant to corrosion, fatigue and crack propagation, thereby extending structural life and reducing maintenance and related costs.

IMPROVEMENT OF THE PERFORMANCE - In addition to reducing the weight, the use of composites entails the construction of more aerodynamically-efficient surfaces, increasing the speed and range of the aircraft.

THE EUROPEAN COMMISSION APPROVED THE PROGRESS OF THE CLEAN SKY PROGRAMME

The site of Leonardo at Pomigliano d'Arco hosted the visit of the European Commission to evaluate the progress of the "Regional" Clean Sky Programme.

During the first work session (Intermediate Progress Review Meeting), the European Commission certified the results of the demonstrations completed as part of the first stage of the programme (Clean Sky 1), positively assessing the progress of the research activities to complete the Demonstration Contractual Plan by 2016.

The second session (First Annual Review) focused on the Clean Sky 2 Regional Innovative Aircraft Demonstration Platform (REG IADP), led by the Aircraft Division in collaboration with Airbus Defence & Space, Liebherr, many industries, universities, research centres and SMEs, associated as core partners.

SUCCESS OF LEONARDO AT SESAR'S OPEN DAY

Leonardo participated in the SESAR EXE-805 Open Day which completed the RTS (Real Time Simulation) validation campaign, the largest one conducted to date by SESAR in terms of system integration and complexity of the utilisation operational scenario: the three validation weeks at control centre of Ciampino involved ENAV, Leonardo Security & Information Systems Division and the partner Airbus.

The validation exercise was carried out in an extremely realistic environment, considering the air space of the control centre of Ciampino and the Terminal Manoeuvring Areas (TMA) of Milan and Padua using a significant traffic load generated by the two simulation rooms (20 controllers involved) and two pilot rooms (23 pilots involved).

DEVELOPMENT OF TECHNOLOGY AND PRODUCTION SKILLS IN THE HELICOPTER SECTOR

The collaboration agreement signed in February 2016 between Leonardo and the Nanyang Technological University of Singapore is aimed at contributing to the technological progress in the aerospace field by sharing talents and know-how, promoting scientific research and developing industrial and engineering skills.

This collaboration will explore new technological opportunities in the helicopter field, a sector that is rapidly evolving following the progress in composites, which are lighter and more robust, focusing on the reduction of hydraulic and dynamic components and the increase in the efficiency of industrial processes. It will also consider aerodynamic modelling that can ensure an overall improvement of the flight performance.

Prevention and management of emergencies

Collaborating in the prevention of landslides and flooding, coordinating relief efforts in the event of earthquakes or fires, monitoring the critical areas from above. These are just some of the applications of Leonardo Space sector technologies and solutions through COSMO-SkyMed, the most ambitious earth satellite observation programme ever developed to prevent environmental disasters, study the earth surface and for safety.

COSMO-SkyMed is based on a constellation of four identical satellites constructed by Thales Alenia Space Italia and a track-side system developed by Leonardo through Telespazio: four “eyes” to study the earth from space metre by metre, day and night, under all weather conditions.

COSMO-SkyMed operates as part of Copernicus, the programme coordinated and managed by the European Commission, in collaboration with the European Space Agency (ESA) and the European Environment Agency (EEA), to provide Europe with its own earth observation capacity.

LEONARDO FOR THE EARTHQUAKE EMERGENCY

After the earthquakes that devastated central Italy, the Rome and Matera e-GEOS centres worked to produce maps and detailed data about the quake-hit areas, in order to provide information about the damage and support the institutions, the Civil Protection and all those involved in providing relief.

This information was successfully used during past natural disasters, such as the earthquakes that hit L’Aquila in 2009 and Haiti in 2010, the Haiyan typhoon that devastated the Philippines in 2013 as well as in other emergencies where pictures were taken also at night using radar technologies.

THE MOST SOPHISTICATED EARTH OBSERVATION SYSTEM

COSMO-SkyMed’s strength lies in its extraordinary flexibility of use. Radars can operate in spotlight mode (focusing on few square kilometres areas and analysing it with a resolution of up to one metre), in stripmap mode (observing a continuous strip of land) or in scanSAR mode (covering an area of 200 km each side).

The configuration of the constellation to obtain the images of the relevant area takes a short time: from 72 hours when operating under routine conditions to less than 18 hours in emergencies.

Another strength of COSMO-SkyMed is the short interval between two passages on the same point, which is less than 12 hours. This enables constant monitoring of the development of the situation in a specific area.

The Copernicus Emergency Management programme provides the Civil Protection departments of EU member states with a mapping service for the production of maps to assess the damage caused by natural disasters around the world (earthquakes, flooding, fires) in rush mode.

This service is operated 24 hours a day and 365 days a year by e-GEOS as part of an international consortium.

Up to September 2016, it has been used 180 times and produced over 2,300 world maps for over 2,000,000 square kilometres acquired in 50 countries.

The Matera Space Centre, one of the three stations of the Copernicus’ Core Ground Segment, plans, acquires and processes information and delivers it to end users.

The Rome Emergency Mapping Centre coordinates, in particular, emergency-related operations.

COSMO-SkyMed’s system can film land surface up to 450 times a day, producing 1,800 radar images every 24 hours.

To date, no other satellite system has the same state-of-the-art characteristics.

People protection and land monitoring

HARMONISE (Holistic Approach to Resilience and Systematic Actions to Make Large Scale Urban Built Infrastructure Secure) is a collaboration research project set up as part of the Seventh Framework Programme for Research and Technological Development of the European Union.

Technologies of Leonardo support all institutions committed to meeting citizens needs for more safety, from controlling cities, which are increasingly complex and exposed to risks, to monitoring borders.

In this respect, by participating in the HARMONISE project, Leonardo has developed a Living Lab based on a simulation and security supervision system. Thanks to the combined action of its two sub-systems – crowd monitoring and flow analysis – this systems gathers and matches different data flows, producing a single integrated view of the monitored areas potentially affected by urban resilience issues (climate changes, safety during major events, mobility of large flows of people and urban regeneration).

The use of the dual technology applied to unmanned systems is also being expanded to land monitoring. Leonardo is the only European company operating in this sector that is able to provide solutions that integrate radar and electronic sensor platforms with mission and ground control systems.

SAFETY AT THE STADIUM

Leonardo intends to become the reference partner of football teams that want to deal with the growing demand for safety and use of the services of modern sports facilities by using sophisticated technologies.

By signing a three-year agreement with the B league, Leonardo will be the technological partner of the second-tier football league for the football stadiums of the new millennium, reinterpreting the concept of safety as the distinctive element of the new sports facilities. Leonardo will provide football teams with strategic advice and technologies as part of the projects to build new stadiums and renovating the existing ones, pursued by B Futura, the infrastructural platform which became the special-purpose entity of the B league, focusing, in particular, on safety, communication, mobility and environmental issues.

FALCO'S EYE FOR UN

The UN used FALCO unmanned aircrafts with a "turnkey" service whereby Leonardo managed the aircraft and provided the customer with the information gathered and processed.

During its three years of service in the United Nations' MONUSCO mission in the Democratic Republic of Congo to monitor the rebels' activities on the borders with Rwanda and Uganda, five FALCO UAVs of Leonardo operated under extreme climate conditions, with tropical temperatures and humidity, successfully penetrating the thickest bushes with their sensors.

According to the Secretary-General Ban Ki-moon, these vehicles "are reactive, can be perfectly controlled and are an immediate source of information to support the intelligence, surveillance and reconnaissance departments in monitoring any illegal activity by armed groups"¹².

12. *Aeronautica&Difesa*, October 2016, page 19.

LEONARDO SYSTEMS AND SOLUTIONS TO CONTROL BORDERS

During the workshop held in Warsaw and organised by Frontex, the European border and coast guards agency, the Border Guards met research and development experts to contribute to the evolution of Border Security systems and solutions, considering end users feedback.

During this event, Leonardo Divisions unveiled their sophisticated projects, products and technologies for the coordination and management of search and rescue operations, the optical tracking systems to be used in densely populated and congested areas and the day and night optical tracking systems using hyper-spectral technology.

In December 2016, Leonardo organised the third edition of the ISITEP (Inter System Interoperability for Tetra-TetraPol Networks) project at the Roma Tre university. This project, coordinated by Leonardo, defined and developed the intergovernmental agreements, procedures and technologies necessary to develop the cooperation of European police forces at field level.

Cyber security and protecting critical infrastructures

Leonardo participates in the NATO's Computer Incident Response - Full Operational Capability (NCIRC - FOC) programme, developed to ensure the security of information and ICT infrastructures in 52 NATO sites in 29 countries.

Safeguarding energy and transport infrastructures from cyber threats, as well as that of all networks underlying business and financial exchanges, based on national and supranational strategies, is a fundamental aspect in guaranteeing the growth and development prospects of each country.

Leonardo is the technological partner of several governmental institutions and trade and financial organisations for cyber safety prevention, monitoring and management. It is also part of many national and international institutes and networks operating in this sector. With the Chieti-based SOC/CSIRT, Leonardo developed one of the most sophisticated centres at European and international level in terms of variety of services and number of customers served.

Leonardo provides cyber protection services to over 1,500 Italian SMEs, one of the main targets of hackers.

Leonardo intends to strengthen its product portfolio by including the most qualifying aspects of Industry 4.0, including cyber security, digitalisation, automation, widespread sensor application and miniaturisation. These technological trends are the pillars for the creation of new economic, occupational and social value and must be accompanied by a specific and updated cyber security strategy.

EUROPEAN APPROACH OF LEONARDO TO CYBER SECURITY

The European cyber security market is worth €25 billion and €2.4 billion in Italy, with estimated annual growth of 9% for the next five years.

After the last edition held in Tel Aviv which saw the participation of over 10,000 delegates from 50 nations and hundreds of exhibiting companies, Cybertech, the largest cyber security event outside the United States, was held in September for the first time in Europe, specifically in Rome.

In this context, Leonardo presented a public-private cyber security partnership, similar to the "European Cyber Security Organisation" recently set up by Leonardo and other business and governmental partners, which will group leading players and institutions to create synergies with the European investment programmes and ensure the significant growth in size of the sector.

SHARING CYBER SKILLS WITH INSTITUTIONS

Leonardo organised the first Cyber Shield contest to check and assess the maturity and resilience level of the teams in charge of information security when resolving complex issues, by simulating practical incidents. The exercise also involved the personnel of governmental bodies and institutions.

As part of the development of public-private partnerships, Leonardo participates in the initiatives of the Companies's Technical Table, set up by the Department for Safety Information (*Dipartimento delle Informazioni per la Sicurezza* - DIS). The Technical Table "bases its operations on information sharing, in order to enable critical infrastructures and strategic companies member of the DIS to expand their knowledge and strengthen their cyber defence skills"¹³.

In collaboration with the DIS, Leonardo also launched the Malware Analysis laboratory and, in 2017, it will intensify its collaboration and information exchanges with governmental and/or supra-governmental bodies to strengthen the ability to identify and prevent cyber threats.

13. 2016 report on security information policies, pages 10-11.

“CYBER PROTECTED” INFRASTRUCTURES

The approach of Leonardo to safeguarding critical infrastructures is aimed at integrating the protection from physical threats with the cyber protection of data communication networks. With respect to airport safety, the heart of the solution lies in the command and control platform to flexibly and effectively manage the information and data gathered by different sensors, including cameras, infra-red thermal cameras and radars. This is a way to reply to critical situations, by planning the intervention of the operating forces on site and monitoring the evolution in real time. Furthermore, by modelling the actions to be taken in respect of the critical situations pre-identified, operators can minimise intervention times, limiting the damage caused by the threat.

Leonardo installed approximately 300 port and airport safety operation systems and logistic and physical safety systems in 150 countries around the world.

These include the Genoa port which covers an area of approximately 700 hectares of land and 500 hectares of water, with an extension of 22 kilometres along the coast and operating piers long 30 kilometres.