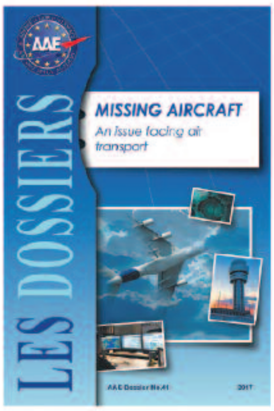
The Quarterly Bulletin of the CEAS

COUNCIL OF EUROPEAN AEROSPACE SOCIETIES

3AF AIAE AIDAA AAAR CzAeS DGLR FTF HAES NVvL PSAA RAeS SVFW TsAGI

Issue 3 - 2017
3rd Quarter



AIRBUS ready for BLADE flight tests

ESA Clean Space Initiative

The long-duration ISS "Proxima" mission

CEAS

WHAT IS CEAS ?

The Council of European Aerospace Societies (CEAS) is an International Non-Profit Association, with the aim to develop a framework within which the major Aerospace Societies in Europe can work together.

It presently comprises thirteen Full Member Societies: 3AF (France), AIAE (Spain), AIDAA (Italy), AAAR (Romania), CzAeS (Czech Republic), DGLR (Germany), FTF (Sweden), HAES (Greece), NVvL (Netherlands), PSAA (Poland), RAeS (United Kingdom), SVFW (Switzerland), TsAGI (Russia); and six Corporate Members: ESA, EASA, EUROCONTROL, LAETA, VKI and EUROAVIA..

Following its establishment as a legal entity conferred under Belgium Law, this association began its operations on January 1st, 2007.

Its basic mission is to add value at a European level to the wide range of services provided by the constituent Member Societies, allowing for greater dialogue between the latter and the European institutions, governments, aerospace and defence industries and academia.

The CEAS is governed by a Board of Trustees, with representatives of each of the Member Societies.

Its Head Office is located in Belgium:
c/o DLR – Rue du Trône 98 – 1050 Brussels.
www.ceas.org

WHAT DOES CEAS OFFER YOU ?

Knowledge transfer:
- A well-found structure for Technical Committees

High-Level European Conferences:
- Technical pan-European events dealing with specific disciplines and the broader technical aspects
- The CEAS European Air and Space Conferences: every two years, a Technical oriented Conference, and alternating every two years also, a Public Policy & Strategy oriented Conference

Publications:
- Position/Discussion papers on key issues
- CEAS Aeronautical Journal
- CEAS Space Journal
- CEAS Quarterly Bulletin

Relationships at a European Level:
- European Commission
- European Parliament
- ASD (AeroSpace and Defence Industries Association of Europe), EASA (European Aviation Safety Agency), EDA (European Defence Agency), ESA (European Space Agency), EUROCONTROL
- Other European organisations

European Professional Recognition:
- Directory of European Professionals

Honours and Awards:
- Annual CEAS Gold Medal to recognize outstanding achievement
- Medals in technical areas to recognize achievement
- Distinguished Service Award

Young Professional Aerospace Forum

Sponsoring

THE CEAS MANAGEMENT BOARD

It is structured as follows:

- General Functions: President, Director General, Finance, External Relations & Publications, Awards and Membership.

- Two Technical Branches:
  – Aeronautics Branch
  – Space Branch

Each of these two Branches, composed of specialized Technical Committees, is placed under the authority of a dedicated Chairman.

The Officers of the Board in 2017:

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EDITORIAL

Jean-Pierre Sanfourche
Editor-in-Chief,
CEAS Quarterly Bulletin

"Dear readers,

When you receive this bulletin, it will be just a few days before the **CEAS Aerospace Europe Conference 2017** opening in Bucharest. Because the programme of this event published in the previous issue has evolved in the course of summer, it has been considered as opportune to provide you with the current organisation status, now very close to the final one. For the delegates and those still considering to join, more background information to this programme can be found in an article giving an overview on the Romania's aeronautical industry.

Thanks to the wonderful work performed by the organisation team and the richness of the programme, this Conference for sure will be attended by a large audience. CEAS is the designated association to deal with all topics concerning aviation, aeronautics, aerospace defence & security and space in Europe, and taking into consideration not only scientific and technological challenges but also strategy, economics, public policy and education aspects. The Aerospace Europe Bucharest Conference will be a new decisive demonstration of CEAS notoriety!

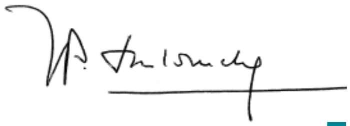
As usual we have tried to cover in this issue subjects of the different branches covering aerospace: civil aviation, aeronautics technology, defence & security and space. Among the papers, are the here below evoked.

In civil aviation area, we provide you with the summary of the excellent dossier realised by the Air and Space Academy (AAE) on the theme "Missing Aircraft – An Issue facing air transport". On 8 March 2014, the Boeing 777 of Malaysia Airlines MH370 disappeared in flight with 239 people on board and more than three years on, no explanation has been found for this dramatic event. The AAE study constitutes a precious analysis while giving recommendations to prevent any further unacceptable cases of missing aircraft.

Currently Cyber Defence is understood as being the fifth domain of warfare, therefore two articles are devoted to this topic: one from the European Defence Agency (EDA) and one from the Royal Aeronautical Society (RAeS).

Three subjects deal with the Space domain: Clean space initiative "Guaranteeing the future of space activities by protecting the environment", ESA Cube sat Nano- satellite missions for technology in-orbit demonstration and a description of the main steps of the long-duration' Proxima' mission on board of the ISS, on the occasion of the return to the Earth of the European astronaut Thomas Pesquet.

Of course the next issue of our bulletin, programmed to appear in the first week of December, will essentially report on the upcoming Bucharest Conference."



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CEAS PRESIDENT'S MESSAGE

Christophe Hermans
CEAS President 2017

CEAS @work

On 7 June we had a regular Trustee Board meeting at the Netherlands Aerospace Center NLR in Amsterdam, hosted by NVvL, that was also attended the Editor-in-Chief of our Space Journal, Hansjörg Dittus (DLR), his editorial team and Philippe Merlo representing our corporate member EUROCONTROL. Important points on the agenda were the preparation of the CEAS/Aerospace Europe Conference 2017, selection of the CEAS award 2018 winner, collaboration with our partners and of course the CEAS Aeronautical and Space Journals.

The CEAS award 2018 winner was unanimously selected by the board and we are honored that we can add Jean-Jacques Dordain, former ESA's Director General, to our list of distinguished award recipients.

After having enjoyed the summer holiday period, work at CEAS has resumed with focus on the final preparations of our Aerospace Europe 2017 conference in Bucharest.

CEAS Aeronautical and Space journals

This year's second and third volumes of both our Journals have been issued in the meantime featuring 36 new interesting articles. Summaries of the CEAS Space Journal articles can be found following the link http://link.springer.com/journal/12567/9/ and for the CEAS Aeronautical Journal at https://link.springer.com/journal/13272/8/.

I would like to take the opportunity to thank all Associate Editors, which you can find listed on the journal's covers, for their valuable support. They act as independent qualified experts responsible for the articles peer review. Their good work significantly has contributed to making the Journals prominent, successful and influential publications, as can be seen in the more than 10,000 full text article downloads yearly!

CEAS batched thematic events

On a regular basis the CEAS Technical Committees in close cooperation with our national member societies organize international thematic events in several fields. This year's CEAS batched events in aeronautics are:

- 4th Guidance, Navigation & Control Conference (GNC);
- 23th AIAA/CEAS Aeroacoustics Conference;
- 18th International Forum on Aeroelasticity and Structural Dynamics (IFASD);
- 43rd European Rotorcraft Forum (ERF);
- 21st Aeroacoustics Workshop 'Aircraft Noise Generated from Ducted or Un-Ducted Rotors';
- European Workshop on Aircraft Design Education (EWADE 2017).

CEAS Aerospace Europe Conference in 2017: European Aerospace: Quo Vadis?

The registration for our flagship event, the CEAS Aerospace Europe Conference that will be held in Bucharest from 16 – 20 October, is open. The Romanian society AAAR is offering attendees very attractive fees for participants to the conference that will take place in the prestigious Palace of the Parliament. Please visit the conference website (http://ceas2017.org/) and register. You will be offered an attractive program with 35 plenary speakers and some 300 slots for technical presentations. During the conference we will also hand-over the CEAS award 2017 to Eric Dautriat, former Executive Director of the Clean Sky Joint Undertaking.

Christophe Hermans

AEROSPACE EUROPE CEAS CONFERENCE2017

By Leonard Trifu, Marketing Manager, COMOTI

The information given in the CEAS Quarterly Bulletin 2-2017 reflected the Conference organisation status at mid-May. Since this date, a number of evolutions appeared. The status 05.09.17 here below presented is close to the final programme.

DATE AND VENUE

THE CEAS WILL HOLD ITS 6th BIENNIAL CONFERENCE: 'AEROSPACE EUROPE CEAS CONFERENCE 2017'

FROM 16 TO 20 OCTOBER 2017 IN BUCHAREST – PALACE OF THE PARLIAMENT – 2-4 IZVOR ST. (Sector 5, 050563 – Bucharest, Romania)

The Conference will take place in 7 rooms/halls.

A 300 m^2 space will be available for the exhibition.

PROGRAMME

PLENARY SESSIONS/KEYNOTE SPEAKERS

- **Stephen AIREY**, European Space Agency, France
- **Frank BRENNER**, EUROCONTROL, Belgium
- **Olivier CHAZOT**, "von Karman" Institute for Fluid Dynamics, Belgium
- **Valentin CIMPUIERU**, Romanian Air Traffic Services Administration ROMATSA, Romania
- **Dominique COLLIN**, Safran Group – SNECMA, France
- **Mihnea COSTOIU**, "Politehnica" University of Bucharest, Romania
- **Sir Stephen DALTON**, President of the Royal Aeronautical Society, UK
- **Delia DIMITRIU**, Manchester Metropolitan University, UK
- **Sergiy DMYTRIYEV**, SE Ivchenko-Progress, Ukraine
- **Cătălin FOTACHE**, United Technologies Research Center (UTRC), USA
- **Laszlo FUCHS**, Royal Technical University of Stockholm, Sweden
- **Andrea GENTILI**, European Commission, Belgium
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- **Bruno SAINJON**, European Research Establishments in Aeronautics (EREA), ONERA, France
- **Valentin SILIVESTRU**, Romanian National Research and Development Institute for Gas Turbines COMOTI, Romania.
- **Virgil STANCIU**, Aeronautics and Astronautics Association of Romania (AAAR), „Politehnica" University of Bucharest, Romania.
- **Joachim SZODRUCH**, Hamburg Aviation, IFAR, Germany
- **Michael WINTER**, Pratt & Whitney, USA
- **Sorin ZGURĂ**, Institute of Space Science, Romania
- European Space Agency (representative to be assigned)

TECHNICAL SESSIONS

- **29 ordinary technical sessions** on 23 topics, including an estimated number of 170 peer reviewed papers and 25 oral presentations
- **4 special sessions** including an estimated number of 25 peer reviewed papers
  - "**Constant volume combustion**" organised by COMOTI and will gather presentations of the latest research results in the field. Some of the latest results obtained in the European project TIDE will be presented.
  - "**Aircraft 3rd Generation MDO for Innovative Collaboration of Heterogeneous Teams of Experts**". Three special sessions organized by DLR on the latest results from the AGILE Horizon 2020 project aimed at developing the next generation of MDO and aircraft design and on the exploitation activities dedicated to education, including the "AGILE design challenge", dedicated

to the Academia and Research organizations.

- **"Space Technology and Advanced Research"**. Three special sessions organized by the Romanian Space Agency ROSA to presents results obtained within the STAR research programme.

- **6 workshops** including 15 sessions, with an estimated number of 80 presentations:

  - **"Space Technology and Advanced Research"**. Three sessions workshop organized by the European Space Agency ESA to presents results obtained within the STAR research programme.
  - **"Future Sky".** Workshop organized by EREA, the association of European Research Establishments in Aeronautics on its Joint Research Initiative in which development and integration of aviation technologies are taken to the European level, and based on the alignment of national institutional research for aviation by setting up joint research programmes. The session will be chaired by Mr. Joseph KASPAR, General Manager at VZLU, Czech Republic, EREA Vice Chair and Chair of Future Sky Board.
  - **"ACARE SRIA"**, Workshop organized by the Advisory Council for Aviation Research (ACARE), where the updated Strategic Research and Innovation Agenda (SRIA) will be disseminated and discussed;
  - **"Research Infrastructures in Europe"** Workshop organized by the COMOTI on the current status and future development needs and directions for the research infrastructure. With the confirmed participation of the Italian Aerospace Research Center, CIRA, DLR, the Romanian Ministry of Research and Innovation. Confirmation from several other interested parties is expected.
  - **"Aircraft Flow Control Technologies"**, (AFLoNext). Three sessions workshop presenting the EC project AFLoNext. This is a four-year integrated project (level 2) targeting on maturing flow, loads and noise control technologies for transport aircraft. The workshop aims to dissemination of the project results in flow separation control at local areas of the wing to improve the low-speed performance, and in flow control in the cruise regime for stabilizing the shock-boundary layer interaction for buffet control.
  - **"Future Education and Training"** Two sessions workshop organized by Euroavia the European Association of Aerospace Students, representing the interests of over 2000 students from 38 universities in 19 European countries.
  - **"The 13th European Workshop on Aircraft Design Education EWADE 2017"** will be organized as part of CEAS 2017 as a full day, four sessions event. The workshop will discuss recent advances in aircraft design (research and teaching)and is organized by Prof. Dr.-Ing. Dieter SCHOLZ, MSME from the Hamburg University of Applied Sciences.

EXHIBITION

- Exhibition space (300 m^2) is available during the Conference for interested participants. Booths can be reserved from the organizers. A minimum of 12 m^2 for a booth applies.
- Eleven confirmed exhibitors to date:
  - Romanian Research and Development National Institute for Gas Turbines COMOTI, Bucharest, Romania;
  - Magic Engineering, Brasov, Romania;
  - Dassault Systems, Vélizy-Villacoublay, France;
  - Unison Engine Components Bucharest (GE)
  - National Institute for Aerospace Research "Elie Carafoli", Bucharest, Romania;
  - Aerostar S.A., Bacău, Romania
  - Industria Aeronautica Română (IAR), Brasov, Romania
  - Romaero S.A., Bucharest, Romania;
  - INAS S.A., Craiova, Romania;
  - The European Aeronautics Science Network - Technology Innovation Services BVBA (EASN), Budingen, Belgium;
  - European Space Agency / Romanian Space Agency;
  - National Research and Development Institute for Gas Turbines COMOTI, Bucharest, Romania.

PUBLICATION POLICY

- A book of abstracts will be published and provided to the registered participants in both hard copy and in electronic format.
- The accepted peer reviewed papers will be published, following the recommendations of the Scientific Committee of the Conference, in:
  - CEAS Space and CEAS Aeronautical Journals (Springer), both indexed in Scopus;
  - Transportation Research Procedia (Elsevier) as conference proceedings (listed in the Thompson Reuters database – no impact factor);
  - INCAS Bulletin (Romanian Academy), special section (indexed in International Databases: DOAJ, Index Copernicus™ – Journals Master List, Crossref, ProQuest, EBSCOhost, CNKI-SCHOLAR).

KEY DATES

- **Registration closed: 30.09.2017**
- **Final conference programme: 05.10.2017**
- **Conference sessions: 16 to 20.10.2017**

SOCIAL EVENTS

- **Welcome Cocktail**
- **Conference dinner**
- **Classical music concert**

TECHNICAL VISITS

- Five technical visits are scheduled for the last conference day (3 in Bucharest, 2 outside), aiming to introduce the participants to the most important research and industrial

organisations active in aviation and space in Romania:
– Aerostar Bacau and VinconPanciu wine cellar
– Airbus / IAR Brasov and the Peles Castle
– Magurele, the research and development town
– COMOTI and INCAS Bucharest
– Romaero Bucharest

Peles Castle in Sinaia, Romania

ORGANISATION

- Executive Board: in charge of all major decisions related to the organisation of the Conference.
- Organisation Committee: in charge of all the aspects related to the organisation of the conference, such as logistics, financial administration and sponsor identification:
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- Scientific Committee and Programme Committee: ensure the scientific and technical quality of the papers presented at the Conference.

WEBSITE

- ceas2017.org
- Weekly website updates

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- European Collaborative Dissemination of Aeronautical Research amd Applicatons (E-CAero)
- Romanian Ministry of National Defence
- European Community on Computational Methods in Applied Sciences (ECCOMAS);
- European Research Community on Flow, Turbulence and Combustion (ERCOFTAC);
- “Politehnica” University of Bucharest;
- Aeronautics and Astronautics Association of Romania (AAAR);
- European Turbomachinery Conference (ETC);
- European Mechanics Society (EMS);
- European Association of Aerospace Students (EUROAVIA);
- Romaero S.A., Bucharest
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- European Turbomachinery Society Euroturbo

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- Aerostar S.A., Bacău, Romania
- Magic Engineering, Brasov, Romania;
- Dassault Systems, Vélizy-Villacoublay, France;
- INAS S.A., Craiova, Romania

REGISTRATION & FEES

Number of papers[2]		1	2-3	4-5	> 5
Exhibitor	Standard			1,150 €	
	Early bird			1000 €	
Participant	Standard			400 €	
Additional	Concert			Free	
	Welcome cocktail			Free	
	Conference dinner			75 €	
	Technical visit - ROMAERO			Free	
	Technical visit - Magurele			Free	
	Technical visit - COMOTI and INCAS			Free	
	Airbus / IAR Brasov & Peles Castle			95 €	
	Aerostar Bacau &Vincon Panciu wine cellar			95 €	

SOME WORDS ABOUT THE ROMANIA'S AERONAUTICAL INDUSTRY

After 1990 there was a period of political and economical reorganization and the aviation field in Romania suffered a lot because of this. Many aviation projects were stopped but the factories and research centers managed to stay alive. The current situation looks good despite the fact that a big national project is not present to coagulate the knowledge and capabilities in the field. Thus, the companies within Romania's aeronautical sector have capacities and capabilities for: research, design and development; manufacture of structural components for aircraft (aerostructures); general assembly; integration of systems and modern avionics; maintenance, repair and overhaul; upgrading programs; flight tests and certifications etc. The offer of Romania's aeronautical industry, based on its existing manufacturing facilities, skilled workforce and good experience, covers a wide range of highly qualified aeronautical products and services for civil and military applications: aircraft; helicopters; gliders/motorgliders; aircraft engines; helicopter engines; mechanical assemblies for helicopters; drives and servo valves; landing gears; braking systems; hydro-pneumatic equipment and accessories; electric/electronic equipment; parts, components and sub-assemblies of aerostructures.

There are presented briefly the main players in Romania covering a market of about 400 million Euros with more than 7000 employees.

AEROSTAR S.A., company established in 1953 by Government Decision as the Central Aviation Workshop (Atelierul Central de Aviatie). Over time they have manufactured more than 1900 training aircraft and repaired more than 3500 aircraft and 6000 engines. AEROSTAR operates as a house for integration, manufacturing, upgrade and maintenance in the field of aviation systems and ground defense systems, being a first rank supplier to the Romanian Ministry of Defense. AEROSTAR has expanded into the field of civil aviation, and seeks to become a prime supplier of maintenance and conversion/upgrade activities for civil aircraft, as well as a major subcontractor of parts, aero structures, sub-assemblies and equipment for the civil and general aviation. Its main activities are in the field of aircraft maintenance and upgrading; production of aircraft, aero structures and aviation components; ground artillery systems; electronic systems and equipment; production of hydro-pneumatic equipment, landing gears and aircraft spare parts; logistic support activities. The offer of AEROSTAR consist in: aerospace and defense systems (landing gears and hydraulic systems; MiG-21 LANCER upgrade program: AEROSTAR provides integrated logistic support for the program; production and integration of electronic, communication and IFF systems for air, land and naval platforms; integrated artillery systems, engineering equipment, truck-mounted howitzers, armored vehicles; 122mm Multiple Rocket Launcher for the Romanian army, complying with NATO standards); military aircraft maintenance and overhaul (the program include all specific processes related to airframes, engines, electric and electronic equipment, hydraulic equipment and aggregates – for most aircraft in the service of Romanian Air Forces, as well as for aircraft in the service of other air forces); civil aviation programs (providing maintenance / modification of Boeing 737 aircraft series 200-900, BAe 146 100-300 / AVRO RJ, Airbus 320 family and for engines Rolls-Royce Model 250; the Iak-52 aircraft family, which includes the standard, Iak-52W and Iak-52TW variants IAK-52 light aircraft developed in three versions: IAK-52, IAK-52w AND IAK-52TW; Ultralight aircraft – Festival; production of aerostructures, components and assemblies).

AVIOANE Craiova S.A., founded in 1972 to develop, manufacture and provide logistic support for the military aircraft of the Romanian Air Force. The company began by co-operating with former Yugoslavia, developing the joint project of the ground attack aircraft IAR-93. During the 1980's, an advanced jet trainer IAR-99 was entirely designed and manufactured; the upgraded version IAR-99 SOIM is still currently in production and in the service of the Romanian Air Force. The company has capabilities for design, manufacture and certification in its own flight test facilities. Products and services of AVIOANE Craiova includes: advanced jet trainer and close air support aircraft - IAR 99 SOIM; manufacture of aerostructure components; maintenance, repair and overhaul of military aircraft; mechanical, electric and electronic equipment repairs; a wide range of products and services for civil aviation, including co-operation programs with companies such as: Fokker Aerospace - structural parts for Gulfstream IV aircraft, S.A.B.C.A. - Belgium - parts and sub-assemblies for Airbus 330 / 340 aircraft, REIMS Aviation – France - parts and structural sub-assemblies for F 406 aircraft, IAI – Israel – manufacture of aerostructure components; manufacture of industrial products.

AEROFINA S.A., founded in 1980 and it was integrated into the defense industry, being included into the National Centre of Romanian Aeronautical Industry. After 1993, it was included into the Ministry of Defense structure as a military production unit, diversifying its production portfolio towards land, sea and air techniques. It is now a fully private company. Due to its experience in the area of aircraft equipment, AEROFINA has focused primarily on research and design for aviation, participating in the major procurement programs of the army. AEROFINA has participated in all major Romanian aviation programs, for equipping the parachute units with airborne technique, and delivered equipment for armored and naval technique. AEROFINA carries out programs for research-design, production, testing/evaluation, maintenance and integrated support for instruments, equipment, rescue systems and devices for the military sector. The products and services of AEROFINA include: military products (components for the training and ground attack aircraft IAR 99 SOIM; data acquisition and recording systems with static memories; SCHV-0 ejection seat; onboard and ground equipment for military aircraft; pyrotechnics for KM-1M ejection seats; launcher for MAGIC-2 missile; components for IAR-330 Puma helicopter; instruments and equipment for armament systems; support equipment for maintenance of aircraft and armament systems); industrial products. AEROFINA has programs of research-design, production, test/evaluation, maintenance and integrated support at the client for structural elements and equipment for locomotives and carriages and railway infrastructure equipment.

IAR S.A. Brasov has been dedicated to post-war production of helicopters in cooperation with the French company Aerospatiale. The company has also manufactured gliders and motor gliders, light aircraft with turboprop engine, piston engine aircraft. IAR SA is authorized for activities of maintenance and repair and has capabilities for: manufacture of aeronautical structures; upgrade and overhaul of IAR-330 PUMA helicopters; upgrade and overhaul of IAR-316B ALOUETTE helicopters. The company has laboratories for avionics and onboard instruments, hydraulic equipment, fuel equipment, electrical equipment. IAR Brasov is involved in programs of cooperation with prestigious firms worldwide for processing, production of parts and subassemblies for various aircraft. The products and services of IAR Brasov include: IAR 330 L PUMA Helicopter offered in the following versions: military transport, inter-operability with NATO forces, VIP/Executive transport, combat support (armed with missiles), combat search and rescue; IAR 330 L PUMA Helicopter upgraded with SOCAT system (SOCAT - "Anti-Tank Optronic Search and Combat" is the result of an upgrading program for the IAR 330 PUMA helicopter in the service of the Romanian Ministry of Defense); IAR 330 L PUMA – version for the Navy Helicopter for anti-submarine and anti-surface warfare; IAR 330 SM: Puma helicopter upgraded with new engines, 4 axis autopilot, new integrated avionics, etc. Other products and services of IAR Brasov are: aerostructures, electrical wiring, electrical distribution and control panels; design, stress calculation, testing, certification; systems installation/integration.

ROMAERO S.A. a company whose history in the aviation industry extends over a period of more than 90 years. The company has designed, built and repaired a large number of civil and military aircraft including BAC 111. The company has integrated facilities for the manufacture of aircraft, aero structures, parts, for processing, providing also maintenance and repair services for various types of aircraft and aircraft components. ROMAERO operates as an integrated facility, the maintenance and repair activities being supported by the capabilities of mechanical processing and thermal treatments. As an airframe manufacturing approved organization, ROMAERO acts as a subcontractor of major aircraft producers. ROMAERO has been appointed as "National Service Centre for C-130 Hercules" and signed a strategic partnership with Lockheed Martin and Derco for the maintenance and upgrading of the Romanian Ministry of Defense C-130 Hercules Fleet. The products and services of ROMAERO include: components and subassemblies for: BAe ATP, Agusta A109, Airbus A380, A330/340, B737, B747, B767, B777, Airbus A320, Gulfstream 200, BN-2 Islander, Bombardier CL-415; maintenance and repair for: Hercules C-130, AN-30/26/24, general aviation; checks and structural repairs for: B707, 727, 737, MD-80, BAe ATP, BAe 146, Airbus A320; non-destructive testing, treatment and repair; interior re-configuration, refurbishment, equipment upgrading; technical assistance – for aircraft equipment, aero structures, technologies, processes, using skilled personnel and dedicated software.

TURBOMECANICA S.A. company was founded in 1975 for the manufacture of aircraft engines and aircraft components. Turbomecanica is mainly involved in the development and manufacture of components and sub-assemblies for turbojet and turboshaft engines, mechanical subassemblies and repairs for aircraft engines and dynamic systems for helicopters, providing technical assistance. The company became an important supplier of new products for the Romanian Ministry of Defense. A restructuring program has been initiated, aiming to increase sales and the number of foreign customers. The company relies on the use of its extensive facilities and on its wide expertise, at the same time focusing on the identification of new products and markets. TURBOMECANICA products and services include: parts (gears, cases, sheet metal components, aerodynamic control surfaces); sub-assemblies; accessories for aeronautical engines, helicopter gearboxes and rotor-heads, turbines and turbochargers; airframe components; components for aeronautical applications; aircraft parts and sub-assemblies; dynamic systems for helicopters – repairs / maintenance; industrial gas turbines; overhaul and repairs for the delivered products; technical support at customer's request; repair of similar products or of the same family; repair of power supply units for aircraft engines.

INCAS – National Institute for Aerospace Research "Elie Carafoli" having a long-dated tradition in aerospace engineering and research, using state-of-the-art technologies and a unique infrastructure of national strategic importance. INCAS has been involved in all major national aeronautical programs for the civil and military areas. The basic research accomplished by INCAS aims to increase the knowledge level in the aerospace and aeronautical fields, referring to general aerodynamics, flight and systems dynamics, aerospace structures, aeroelasticity, strength of materials applicable in aeronautics, and aerospace propelling systems. The applied research and the technological development include the achievement of aerospace technologies and materials; electronic, mechanical-hydraulic and pneumatic equipment, experimental models, testing benches, laboratory instruments and tools for the aeronautical industry. For the ease of industrial implementation of research results, the institute is carrying out associated activities such as: technical assistance, consulting, scientific and technical support, testing in special facilities, etc. The major programs in which INCAS is involved are: IAR-99

SOIM (Advanced training and close air support aircraft); UAVs for air surveillance missions and training; ECO 100 (single engine piston light aircraft, two side-by-side seats; the aircraft operates on concrete runways and on grass half-prepared fields). Currently, the institute is widely involved in the European R&D policy, within long-term programs, and is recognized at European and international level due to its extensive involvement. INCAS is involved in national and European programmes such as STAR, NUCLEU, PNCDI II, CLEAN SKY, FP6, FP7, UE – CORINT, FlightPath 2050, ACARE - Advisory Council for Aeronautical Research, EREA - European Research Establishment in Aeronautics, and is one of the founder members of IFAR - International Forum for Aviation Research.

COMOTI - Romanian Research and Development Institute for Gas Turbines, is the only specialized unit in Romania which integrates scientific research, design, manufacture, experimentation, testing, technological transfer and innovation in the field of aircraft turbine engines, gas turbine industrial engines and high speed blade machines. COMOTI enjoys international recognition for its professional and institutional competitiveness in the area of gas turbine engines acknowledged by the award of a significant number of medals and diplomas in international exhibitions held in Geneva and Brussels and by the institute's participation in large-scale European projects, and in projects of cooperation with companies from the US, Italy, Germany, France. The quality of its RDI activities and the constant growth of the institute's domestic and international reputation have allowed the current involvement in scientific research, design, testing and micro production in the following main directions: aircraft gas turbine engines; consumption reduction and energy efficiency; non-conventional energy; environment protection, including noise reduction in aircraft engines and industrial gas turbines. The offer of COMOTI includes: on demand manufacturing, technical assistance, assembly, overhaul and repairs, in accordance with the customer's requirements and needs, with quality assurance, for: industrial and aviation gas turbine engines, electric centrifugal air compressors, electric centrifugal air blowers, cogeneration units - electric turbine generator, high speed blade machines. The European projects target high end research in applied aeronautics and turbine based machines in aviation and industry. In the last years, COMOTI participated in numerous European research projects: Framework Programme V (SILENCER - 2001, METHOD - 2001, JEAN - 2001, ABRANEW – 2003); Framework Programme VI (CoJeN - 2003, VITAL - 2004, XNOISE 2 – 2006, XNOISE 3 – 2008); Framework Programme VII (TEENI-2008, OPENAIR-2009, NINHA-2010, TEAM_Play-2010, ESPOSA-2011, TIDE-2013); Clean Sky Programme (ANCORA-2011, HEXENOR-2011, STARTGENSYS-2011).

STRAERO S.A. is a private research centre acting as a leading provider of aerospace research and development (R&D) services and consulting in Romania. STRAERO has been established as an independent institute in 1991 and its main activities are R&D applications focused on: analysis and experimental testing of structures and materials; analysis of flight control systems; design and manufacture of testing installations; IT solutions. The R&D activities performed in STRAERO are supported by a structure of laboratories and divisions: Analysis Laboratory (structure research, analysis and simulation); Design Laboratory (test installations and mechanical equipment); Test Laboratory (structure and equipment testing facilities); Systems and IT Laboratory (simulations, analysis and synthesis for flight control systems). The main products and service are related to: IAR 99 aircraft; IAR 330 PUMA helicopter; gliders and motor gliders; agricultural aircraft, tourist aircraft; YAK 52 training aircraft ; Israeli GALAXI transport aircraft; test equipment for the automotive industry; UAVs; aeroelasticity studies for wind turbines; seismic qualification tests for nuclear plants; anti-seismic protection systems. STRAERO is involved in national research program (CNMP, CNCSIS, PNII, PNIII) and international ones (FP7 - Joint Technology Initiative (JTI) "CleanSky"; Smart Fixed Wing Aircraft - Integrated Technology Demonstrator).

Apart of these companies, there are many branches of renowned foreign companies in the field of aerospace as well as airlines and other services or products providers.

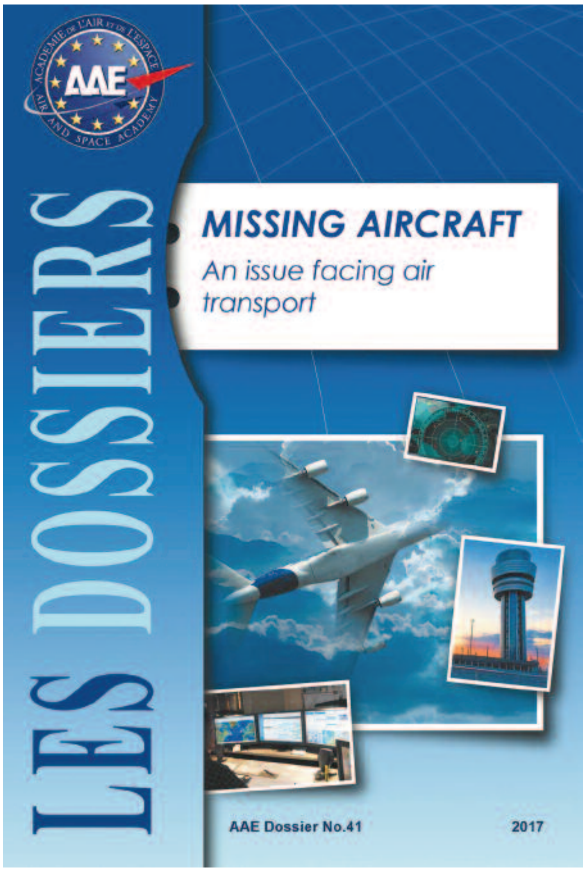
AIAA/CEAS AWARD FOR THE BEST STUDENT PAPER IN AEROACOUSTICS 2017

Part of the yearly Aeroacoustics Conference, jointly organised by the CEAS and AIAA, is a contest for the **Best Student Paper Award**. This year's conference, the 23rd AIAA/CEAS Aeroacoustics Conference held in Denver, Colorado, 4-9 June 2017, originally had 47 abstracts submitted, which eventually resulted in a substantial list of 28 papers written by 27 candidates. Prior to the start of the conference, based on reviewing the papers, a jury of 40 experts reduced this list to a manageable shortlist of 6 candidates. The presentations by these candidates were critically assessed by 16 judges during the conference.

The final winner, with both the highest score for the paper and the presentation, was PhD student **Benshuai Lyu**, supervised by Ann P. Dowling, from the University of Cambridge, UK, with the paper "**On the mechanism and reduction of installed jet noise**" **AIAA 2017-3523**. He received a certificate (see photo), $250 from the CEAS, and $250 from the AIAA.

The CEAS and the CEAS Aeroacoustics Specialists' Committee congratulate Benshuai on winning the 2017 Best Student Paper Award in Aeroacoustics.

MISSING AIRCRAFT– AN ISSUE FACING AIR TRANSPORT



AN ISSUE FACING AIR TRANSPORT

On 8 March 2014 the Boeing 777 of Malaysia Airlines MH370 disappeared in flight with 239 people on board. This disappearance has not been explained yet. How is it possible?

The Air and Space Academy has conducted a reflection about this dramatic subject.

It set up a working group bringing together experts in the different areas involved to look into questions concerning both the technical means enabling reliable positioning of the aircraft in flight and the definition of air-ground communication, with the aim of preventing any further cases of missing aircraft.

The findings of this working group are presented in the Dossier #41 of the Air and Space Academy, which comprises five chapters and eleven annexes.

FIVE CHAPTERS

1. Aircraft that go missing after an accident are usually found, through sometimes with great difficulty.

2. An aircraft can disappear momentarily:
- Despite Air traffic Control,
- Despite Operations control Centres,
- Despite coordination between civil and military air traffic services,
- Despite flights being displayed on the internet.

3. The outcome of the ICAO high level conference on safety of February 2015

4. Some proposals for insufficient tackled issues:
- Flight tracking by airlines > Recommendation 1
- Improving search and rescue (civil/military coordination)
- Recommendation 2
- Developing ground/air co-operation > Recommendation 3
- Transmission of vital data before accidents > Recommendation 4

5. Follow-on action

ELEVEN ANNEXES

1. Air Traffic Management
2. The role of Operations Control Centres
3. Internet sites for tracking aircraft
4. Civil aviation regulators
5. ICAO High-Level Safety Conference (HLSC) of February 2015 – Decisions on global flight traffic
6. Satellite data transmission of information from commercial aircraft flying over maritime or desert areas
7. Recommendations on the role of Air Defence
8. Legal protection of flight recorders
9. The flow and volume of data to be transmitted before the accident
10. List of aircraft missing at sea
11. Glossary

SUMMARY

Our society has become accustomed to access to information in real-time. The media and social networks have turned the Earth into a global village where any newsworthy event is immediately relayed the world over, or at least this is what we imagine. The internet gives us all armchair access to an ever greater stream of constantly updated information, leaving the impression of unlimited access to information and the conviction that technology has no limits.

All-powerful technology has also brought any point of the globe within reach of all the Earth's inhabitants. Aviation has entered our lives and our societies, inspiring at once fascination and fear. Flying has become commonplace, and yet each aircraft incident or accident generates media coverage out of proportion to other means of transport and sets off in-depth investigations. Each tiny detail is dissected, analysed and published. With some rare exceptions, specialists end up with a reasonably clear idea of what occurred, even when the aircraft has been destroyed. So how can we accept the idea that an aircraft can apparently disappear forever, that nobody will ever know where it is nor what happened to it?

Such is the case of the Malaysia Airlines flight MH370 that went missing in March 2014 (references to this accident are given in roman type in the text). It also took a week to locate the wreckage of the Egyptair MS 804 flight after it crashed into the Mediterranean Sea in May 2016, even though the accident happened not far from the coast and that the aircraft was being tracked by radar, since radar becomes ineffective when aircraft drop below the beam (as the investigation is still in progress, no more will be said about this accident).

Here is what must be known to comprehend the incomprehensible:

- with very few exceptions, airlines do not permanently track their aircraft in flight (Malaysia Airlines was no exception);
- air traffic management, because of its fragmentation (many handovers from one control organisation to another), cannot provide continuous flight tracking;
- the fact that flights are displayed on certain Internet sites does not guarantee that these aircraft are permanently monitored in whatever circumstances;
- it can be very complicated to locate a plane which came down over the ocean or in inhospitable or poorly accessible regions (on average a little over one case per year);
- because of defects in current ATM communications and monitoring systems, it is not uncommon to lose contact with a plane for a time even during normal flight (the loss of contact with flight MH 370 was not so surprising therefore at the time for the various controllers involved);
- loss of contact with a plane can indicate a potential threat for the country over which it is flying. This is why the air defence systems of some developed countries have the task of dealing with these missing planes. This requires coordination between civil and military air traffic control and action on the part of Air Defence (it should be noted that such means were not implemented in the case of the MH 370). This dossier gives examples of aircraft that went missing after accidents and draws up a list of the issues involved. It then examines the current state of communications between ground and air, studies the tracking systems used by air traffic control services and airlines as well as those available to the public on the Internet, and explores how states can exercise sovereignty over their airspace thanks to the different missions and means of their air forces.

This dossier also comments on the recommendations and announcements made by various players at the High Level Safety Conference (HLSC) of the International Civil Aviation Organization (ICAO), in early February 2015, which dealt, in particular, with "Global Tracking".

The dossier goes on to explore the following four major themes:

- aircraft tracking;
- improving search and rescue;
- developing ground/air co-operation;
- transmission of vital data before accidents;

which give rise to the following four recommendations.

► Recommendation 1

Thanks to improved satellite services it will be easier and less expensive for airlines to permanently track their aircraft in flight, even over zones with no radar cover. It is highly desirable that this tracking be made obligatory, with a position report every minute when a serious anomaly is detected; this would make it possible to locate an aircraft rapidly in the event of a crash, thereby meeting the needs of the aeronautical community (investigations and flight safety) and the victims' families. Aircraft manufacturers and airlines should set up tracking systems that cannot be disconnected, to prevent wilful action being taken on board to make an aircraft "disappear".

► Recommendation 2

Loss of contact with an aircraft should always be regarded as a serious event requiring rapid implementation of appropriate means to dispel any doubt, although the response should be progressive, ending up with the highest level of intervention from air defence. No passiveness should be tolerated. The necessary means and procedures should be set up to ensure interconnectivity between the air traffic services of adjacent countries and cooperation between civil and military authorities.

► Recommendation 3

An in-depth study should be launched into the criteria and means to be set in place for detecting and perhaps helping to resolve an emergency situation. This study should also comprise an analysis of the advantages and disadvantages of new resources.

► Recommendation 4

Rapid collection of all information needed to elucidate an accident is a prerequisite for aviation safety. In certain circumstances, but not always (poorly accessible areas for example), deployable recorders would be an acceptable solution. But it is clearly much better to transmit the relevant data prior to the accident, guaranteeing access to information in all circumstances. Joint experiments should rapidly be launched by manufacturers and operators, on new aircraft in particular, to build up a clearer picture of this solution, before it can become a credible alternative to the requirement for deployable recorders.

This study also threw up questions which go beyond the scope of this dossier. Certain preliminary proposals, in particular concerning emergency situations, could be put forward in a future AAE dossier dealing with hijacking of aircraft.

1) Aircraft must be tracked permanently. Who would be tasked with this? With what technical resources? And what funding?

2) What are the criteria for detecting an emergency on board a plane in flight? What is the relevant information and how can it be relayed so that the ground team is informed of this emergency? What new systems will ensure that transmission means cannot be disconnected? And that the confidentiality of possibly real-time audio and video communications to the ground is respected? What would be the role of the air forces in such situations?

3) How to restrict access to protected data destined for the investigation if it is transmitted by radio before the crash?

4) How to make more consistent the current disparate set of ground/air communications and positioning systems? How to ensure protection from the threat of malevolent acts targeting these currently unprotected systems, in particular ADS-B?

5) How to reconcile the multiplicity of legal, cultural, religious and ethical claims surrounding recovery of the victims' remains, a potentially extremely expensive operation, particularly when the technical data has already been obtained without visiting the wreck?

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2017 EASA ANNUAL SAFETY REVIEW

EASA has published on 14 June the 2017 Annual safety Review. The analysis in this year's review provides a statistical summary of aviation safety in the EASA Member States and identifies the most important safety challenges faced in European aviation today. This data-driven analysis will lead to the development of safety actions across domain-specific safety risk portfolios and will define the priorities on which the Agency will focus on. These priorities will be presented in the next edition of the European Plan for Aviation Safety to be published in December 2017.

FOREWORD BY THE EXECUTIVE DIRECTOR

2016 has brought continued improvements in safety across almost every operational domain. It was the lowest year in terms of fatalities in airline operations in aviation history. However, the fatal accident involving a cargo flight in Sweden that took place in January highlighted the complex nature of aviation safety and the significance of addressing human factor aspects in further reducing accidents. Additionally, the tragic accident involving an EC225 helicopter in Norway in April 2016 shows the importance of joining forces and together maintaining safety as an aviation community.

During the past year EASA has advanced and developed key strategic activities across a diverse range of new and emerging issues. The Agency has recently published the notice of proposed amendment on the regulatory framework for the operation of drones. With the emergence of new and more sophisticated cyber threats, EASA has commenced the implementation of the European Centre for Cyber Security in Aviation. The Agency continues to work with partners in Europe and at a global level to monitor the threat of conflict zones and pro-vide rapid advice to civil aviation.

Over the past year, the Agency has further refined the way in which it applies Safety Risk Management principles. In particular, the collaborative analysis groups, which bring together expertise from authorities and industry stakeholders have proved to be successful tools in further underpinning a data-driven approach to managing safety, which is now also reflected in the latest edition of the European Plan for Aviation Safety (EPAS). These various efforts will help to ensure our continued vigilance and help improve safety for today and into the future.

Patrick Ky
Executive Director

AIRBUS HELICOPTERS UNVEALED AT LE BOURGET AIRSHOW "RACER" HIGH-SPEED DEMONSTRATOR

On 20 June at Le Bourget air show Airbus Helicopters has unveiled the aerodynamic configuration of the demonstrator it is developing as part of the Clean Sky 2 research programme, concerning the high-speed helicopter code-named "RACER": Rapid and Cost-Effective Rotorcraft.

This demonstrator will incorporate a lot of innovative features and will be optimized for a cruise speed of more than 220 knots (400 km/h).

It will aim at achieving the best trade-off between speed, cost-efficiency, sustainability and mission performance.

Final assembly of the demonstrator is expected to start in 2019, with a first flight in 2020.

"Today we unveil our bold vision for the future of high-speed rotorcraft", said Guillaume Faury, Airbus Helicopters CEO. "This new project, pulling together the skills and know-how of dozens of European partners through the Clean Sky 2 initiative, aims to bring increased speed and range at the right cost, thanks to a simple, safe and proven aerodynamic formula. It will pave the way for new time-sensitive services for 2030 and beyond, setting benchmarks for high-speed helicopter transportation." "We want to offer high speed at the right cost, over a typical range of 400 nm (740 km)".

Among main characteristics:

- The helicopter will have: a main rotor, 2 lateral pusher rotors, a joined "box-wing" configuration.
- The innovative "box-wing" design, optimised for aerodynamic efficiency, will provide lift in cruise mode while isolating passengers during ground operations from the "pusher" lateral rotors designed to generate thrust in forward flight.
- Optimised for performance and low acoustic signatures, these lateral rotors as well as the main rotor will be driven by two RTM322 engines (more precisely adaptations of the present RTM322 which equip the NH90).
- An "eco mode" will be tested to demonstrate an electric-powered "start and stop" of on engine in flight, thus generating fuel savings and increased range. This concept will allow a pilot to "pause" an engine while in cruise, generating fuel savings of about 15% and longer range.
- An auxiliary electric smart rotor will provide additional power when needed (acceleration, landing, autorotation, etc.).
- The demonstrator will also benefit from a hybrid metallic (composite airframe, specially designed for low weight and low-recurring costs.
- It will also be equipped with a new high voltage direct current electrical generation, which will significantly contribute to weight reduction.

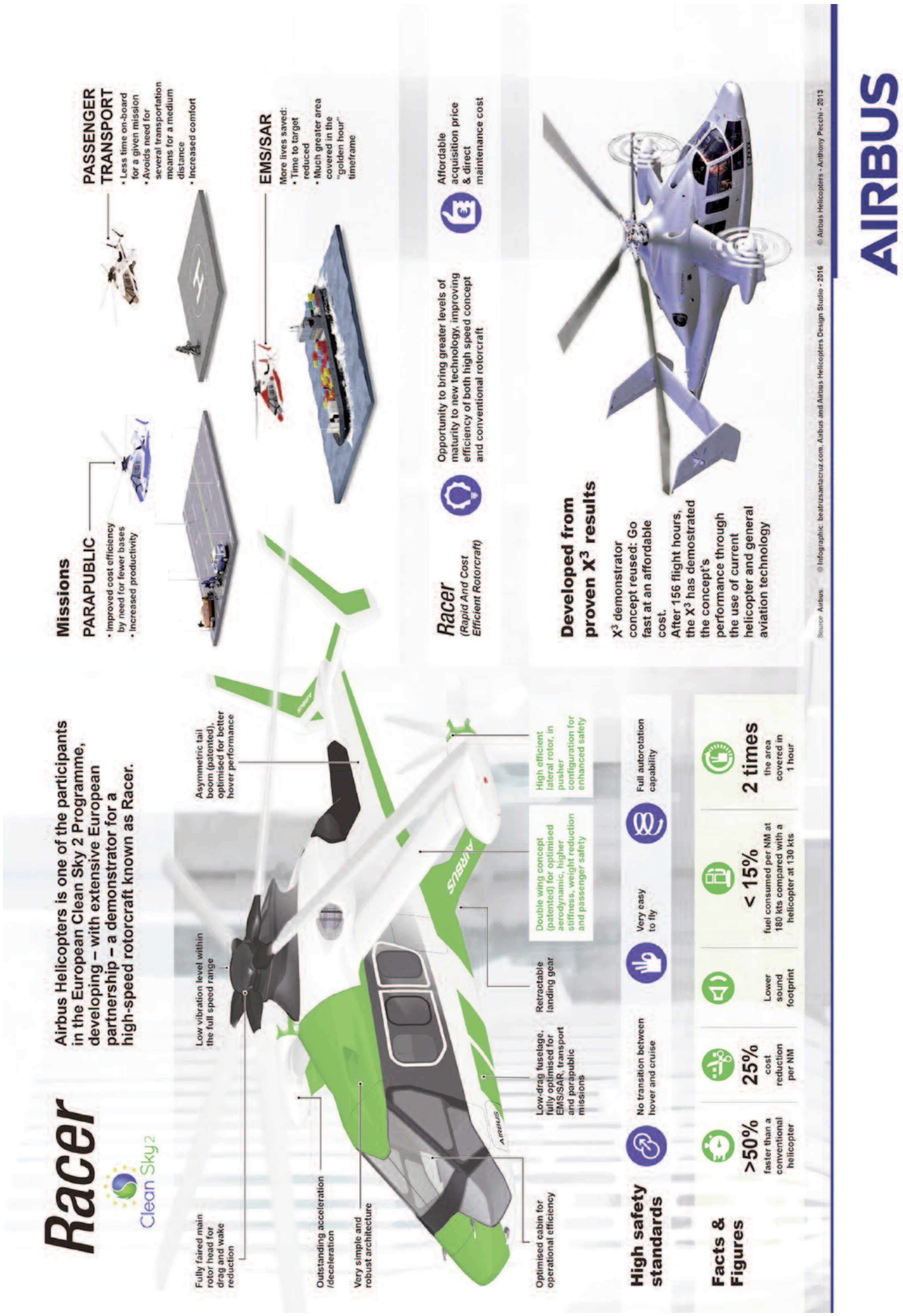
Building upon the success of self-funded X3 demonstrator (which flew for the first time in 2010) which validated the "compound" aerodynamic configuration – a combination of a traditional main rotor and innovative lateral rotors – the Racer project is this concept closer to an operational design and demonstrate its suitability for a wide spectrum of missions where increased speed and efficiency will bring significant added value for citizens and operators. This is specially the case for:

- Emergency medical services;
- Search and rescue operations;
- Public services;
- Commercial air transport;
- Private and business aviation.

The development of the "Racer" will involve 38 partners (main European) from 13 countries. Foe example, Avio will make the gearbox, GE UK will do the wings, Safran Helicopters Engines will make the adapted RTM322.

Nota : The main components of the « Racer » R&D programme are shown in page 16.

Synthesis written by J-P Sanfourche on the basis of information provided by Clean Sky


Racer
Clean Sky 2
Airbus Helicopters is one of the participants in the European Clean Sky 2 Programme, developing – with extensive European partnership – a demonstrator for a high-speed rotorcraft known as Racer.
Fully faired main rotor head for drag and wake reduction
Low vibration level within the full speed range
Asymmetric tail boom (patented), optimised for better hover performance
Outstanding acceleration /deceleration
Very simple and robust architecture
Optimised cabin for operational efficiency
Low-drag fuselage, fully optimised for EMS/SAR, transport and parapublic missions
Retractable landing gear
Double wing concept (patented) for optimised aerodynamic, higher stiffness, weight reduction and passenger safety
High efficient lateral rotor, in pusher configuration for enhanced safety
High safety standards
No transition between hover and cruise
Very easy to fly
Full autorotation capability
Facts & Figures
>50% faster than a conventional helicopter
25% cost reduction per NM
Lower sound footprint
< 15% fuel consumed per NM at 180 kts compared with a helicopter at 130 kts
2 times the area covered in 1 hour
Missions
PARAPUBLIC
• Improved cost efficiency by need for fewer bases
• Increased productivity
PASSENGER TRANSPORT
• Less time on-board for a given mission
• Avoids need for several transportation means for a medium distance
• Increased comfort
EMS/SAR
More lives saved:
• Time to target reduced
• Much greater area covered in the "golden hour" timeframe
Racer (Rapid And Cost Efficient Rotorcraft)
Opportunity to bring greater levels of maturity to new technology, improving efficiency of both high speed concept and conventional rotorcraft
Affordable acquisition price & direct maintenance cost
Developed from proven X3 results
X3 demonstrator concept reused: Go fast at an affordable cost.
After 156 flight hours, the X3 has demostrated the concept's performance through the use of current helicopter and general aviation technology
Source: Airbus
© Infographic: beatrizsantacruz.com, Airbus and Airbus Helicopters Design Studio - 2016
© Airbus Helicopters - Anthony Pecchi - 2013
AIRBUS

AIRBUS READIES FOR "BLADE" FIRST LAMINAR FLOW TESTS

Airbus is preparing the A340 BLADE aircraft (BLADE: Breakthrough Laminar Aircraft Demonstrator in Europe) for its first flights aiming to test a breakthrough new wing with a laminar profile to help reduce fuel consumption and increase efficiency.
The aircraft being used for these tests is the 25 years old A340-300 prototype MSN0001 (F-WWAI).

In order to test the laminar profile wing, it has had 9 m sections of each wing replaced with the two special outboard sections manufactured by SAAB (port) and GKN (starboard).

A MAJOR MILESTONE FOR THE SFWA/BLADE PROJECT CONDUCTED BY CLEAN SKY WITHIN FP7

In particular, a significant development has been made by SAAB within Clean sky for the BLADE flight demonstrator, itself part of SFWA (Smart Fixed Wing Aircraft) project.
The newly developed and manufactured component is an integrated wing leading edge and upper wing cover in carbon-fibre-reinforced composites, which form part of the port wing of the BLADE flight demonstrator. This key part has travelled to Aernova (Spain) for the assembly phase of the laminar wing, was then installed by Airbus on its A340-300 MSN0001.

The idea of laminar flow profiles is that they are shaped in such a way that the air flows parallel and uniformly over the top of the wings as long as possible. For laminar profiles it is important that they are extremely smooth with precisely finished surfaces. This means building wings without rivets or other factors that could disrupt the airflow. This, in turn, reduces both fuel consumption and CO_2 emissions.
The A340 BLADE, after having undergone final ground tests at Tarbes (France) will fly about 150 hours to test the wing.
Airbus says it expects savings of up to 5% for short-haul aircraft.

The laminar technology is expected to be used to develop new wings for Airbus aircraft, which are made by Airbus Broughton in North Wales.

Synthesis written by J-P Sanfourche on the basis of information provided by Clean Sky

EVENT REVIEW – DIGITAL CONNECTIVITY AND CYBERSECURITY

ROYAL AERONAUTICAL SOCIETY

The Royal Aeronautical Society Avionics and Systems Specialist Group and Air Transport Specialist Group teamed up on this occasion to pull together a group of industry specialists to discuss and review the evolving aviation cybersecurity environment.

The objective of the conference was to bring together qualified professionals to review how the aviation industry's overall operational environment is changing and to review how this has increased the requirement for more stringent and careful consideration of cybersecurity. The conference discussed the evolving Airport systems environment. Looking at how airport systems are now evolving and being more integrated, instead of the more traditional disparate standalone systems. For instance, air navigation aids first introduced as standalone systems, then tied together at the air traffic control room, and now even more integrated - the needs to secure these airport systems has certainly increased. This concept is developing further with the possibility of having remote control towers and having the airport environment virtualised on displays using various visual techniques (i.e. cameras) at the airports, thus requiring the added security to the entire network and to be protected from any cyber-attack incidents.

The discussion progressed to review what cyber protection actually was with an interesting viewpoint regarding redundancy, a concept second nature to any aeronautical engineering professional. Redundancy built into a network increases reliability, but in the case of cyber security not resilience and in order to protect from cyber threat, then resilience is exactly what needs to be introduced.

These concepts of increased resilience were explored in more depth and the conference also heard from the view of cybersecurity from the airborne equipment perspective. The avionics world is evolving to utilise connectivity in more and more ways to and from the aircraft to increase operational efficiency and offer passengers the ability to stay connected while in the aircraft. These connectivity benefits are huge for operators and passengers; however it could offer a vulnerability that was not there previously. Avionics manufacturer Rockwell Collins discussed one of it's latest Secure Router products and explained how the process of securing the device was a continual and evolving requirement requiring significant and repetitive investment to stay ahead of an ever evolving threat.

Moving away from the technology, the event also reviewed the latest regulatory and legal standpoints of cyber security. The presentations from these sectors of the business were very interesting and showed that although structure was in place in the regulations there is room for interpretation.

The strands discussed in the conference were of interest to the attending group, so much so that debate and discussion was continuous and lively, it is clear that this topic is one for further debate and worthy of a more significant follow up event.

The Royal Aeronautical Society is looking forward to hosting the next iteration of this topical debate and welcomes attendees to participate.

If you would like more information about our future events, please contact: conference@aerosociety.com

Conferences and Events
15 August 2017

EUROPEAN DEFENCE AGENCY

Fact sheet

www.eda.europa.eu

THE EDA CYBER DEFENCE PROJECTS

GENERAL BACKGROUND

Cyberspace is understood as the fifth domain of warfare equally critical to military operations as land, sea, air, and space. Success of military operations in the physical domains is increasingly dependent on the availability of, and access to, cyberspace. The armed forces are reliant on cyberspace both as a user and as a domain to achieve defence and security missions.

The Cyber Security Strategy for the European Union, which was released in February 2013 and endorsed by the Council in June 2013, emphasises, "Cyber security efforts in the EU also involve the cyber defence dimension." Consequently, the European Council adopted a "Cyber Defence Policy Framework" in November 2014, highlighting five priorities:

- Supporting the development of Member States' cyber defence capabilities related to CSDP;
- Enhancing the protection of CSDP communication networks used by EU entities;
- Promotion of civil-military cooperation and synergies with wider EU cyber policies, relevant EU institutions and agencies as well as with the private sector;
- Improve training, education and exercises opportunities;
- Enhancing cooperation with relevant international partners.

In the European Defence Agency (EDA) capability development plan, cyber defence is one of the priority actions. A project team of EDA and its participating Member States' representatives is responsible for jointly developing cyber defence capabilities within the EU Common Security and Defence Policy (CSDP). A network of EDA and Member States R&T experts supports this work by collaborative activities delivering the required technologies at the right time. All of this is positioned next to existing and planned efforts by civil communities (national and EU institutions) and NATO within the remit of the NATO-EU Joint Declaration signed at the NATO summit in Warsaw in July 2016. Given that threats are multifaceted, a comprehensive approach that fosters cooperation between the civil and military Communities of Interest (CoI) in protecting critical cyber assets is the key enabler for these synergies.

EDA CYBER DEFENCE PROJECTS

The Agency is active in the fields of cyber defence capability development and Research & Technology (R&T). In accordance with the 2014 Capability Development Plan Revision the focus lies on:

- Supporting Member States in building a skilled military cyber defence workforce.
- Ensuring the availability of proactive and reactive cyber defence technology.

Training & Exercises

Following a structured cyber defence training need analysis, which is expected to be updated soon, EDA develops, pilots and delivers a variety of cyber security & defence courses from basic awareness over expert level to decision maker training. This is accompanied by exercise formats for comprehensive cyber strategic decision making and cyber defence planning for headquarters. In the future, pooling and sharing of training and exercises will be facilitated at European level by an EDA developed collaborative platform, the Cyber Defence Training & Exercises Coordination Platform (CD TEXP).

The "Demand Pooling for the Cyber Defence Training and Exercise support by the private Sector" (DePoCyTE) project is currently under preparation. It aims at improving participating Member States' access to relevant cyber defence courses provided by the private sector in a costeffective way. The project is designed to support the development of a common European cyber defence culture.

Member States' collaborative project ideas include the increasing mutual availability of virtual cyber defence training and exercise ranges (Cyber Ranges) for national cyber defence specialists training. The ranges are multi-purpose environments supporting three primary processes: knowledge development, assurance and dissemination. Accordingly, a federation of ranges may leverage three complementary functionality packages: Cyber Training & Exercise Range, Cyber Research Range as well as Cyber Simulation & Test Range functionalities.

Cyber Situation Awareness

EDA is currently also working on cyber defence situation awareness for CSDP operations and how to integrate cyber defence in the conduct of military operations and missions. Together with the EU Military Staff, the Agency actively contributes to the cyber defence focus area of the US-led Multinational Capability Development Campaign.

The aim of the deployable Cyber Situation Awareness Package (CySAP) for headquarters project is to integrate

these functions and to provide a common and standardised cyber defence planning and management platform, that allows Commanders and their staff to fulfil cyber defence related tasks in their day-to-day business.

Advanced Persistent Threats (APT) Detection

Governments and their institutions are among the most prominent targets for APT malware, mostly aiming at cyber espionage. Intrusions are either discovered too late or not at all. Early detection is crucial for a concept to properly manage the risk imposed by APT. After a very successful feasibility demonstrator EDA is leading a followon project with a group of interested Member States to develop an even more capable solution as an operational prototype.

Digital Forensics for Military Use

The collection and evaluation of digital evidence in a military context becomes more and more important, in order to learn lessons from previous attacks (Post-Mortem Analysis), to attribute attacks to perpetrators, to harden military information infrastructures and to improve online analysis capabilities (Ante-Mortem Analysis). The EDA project for a Deployable Cyber Evidence Collection and Evaluation Capacity (DCEC2) develops a technical demonstrator for a digital forensics capability for the military that specifically responds to the requirements of deployed military operations, such as force protection, agility and rapidity.

CYBER DEFENCE STRATEGIC Research Agenda (CSRA)

Cyber security technologies are relevant to both the civil and the military domain (“dual-use”). Considering on-going and future civil research, for example within the EU Research Framework Programmes, and the high resilience required in defence, it will be crucial to precisely target research & technology (R&T) efforts on specific military aspects. The CSRA is considering these aspects and will include a R&T roadmap for the coming years. It will be part of an Overarching Strategic Research Agenda (OSRA) for the military and will be aligned and delineated with other research agendas in the cyber security & defence domain. Coordination of research projects with other EU stakeholders such as the European Commission, the European Space Agency and the European Cyber Security Organisation is also implemented.

Latest update: 6 September 2017

CLEAN SPACE INITIATIVE: "GUARANTEEING THE FUTURE OF SPACE ACTIVITIES BY PROTECTING THE ENVIRONMENT"

By Luisa Innocenti, Head of the ESA Clean Space Office – Sara Morales Serrano, ESA – Jessica Delaval, JPSI for ESA

Globally, awareness of the environmental impacts of space activities is increasing, as reflected by fast-evolving regulation. In particular, the necessity of preserving the Earth's orbital environment as a safe zone free of debris is an increasingly important driver for the selection of space programmes.

Clean Space is an ESA initiative that directly addresses, through the Agency's technology programmes, the sustainability of space activities on Earth and in Space. Since 2012, the Clean Space initiative has enabled ESA to become a global pioneer and leader on the sustainable use of space, in particular by bringing a system level approach that addresses the entire lifecycle of the various Agency's space projects, from the early stages of conceptual design until after the end-of-life, including preparation for future active debris removal mission.

Clean Space has three branches, reflecting its mission to assess the environmental impact of the space programmes as a first step, to finding ways to address them in future and contributing to a more sustainable and competitive European space industry (Figure 1).

Figure 1 : Clean Space infographic. Credit: ESA

These branches are:
- EcoDesign: designing to address environmental impacts and foster green technologies;
- CleanSat: designing to reduce the production of space debris;
- e.Deorbit: removing a large piece of space debris from orbit.

ECODESIGN

The objective of EcoDesign is to reduce the environmental impact of the space sector by developing green technologies and applying ecodesign during space missions. As a second objective ecoDesign analyses the risks posed by REACH and develop technologies to replace REACH-affected substances.

Life Cycle Assessment

ESA has been pioneering the analysis and reduction of environmental impacts within the space sector. This has been achieved through the application of "Life Cycle Assessment" (LCA), a standardised technique that is the international tool for the quantification of environmental impacts. The LCA methodology, initially developed for mass produced products, was first applied to space in 2011, when an LCA study was carried out on the European launcher family (A5 ECA/ES, Soyuz, Vega).

The success of this study led to an extension of the LCA to satellites, with four types of mission assessed (Earth Observation, Telecommunications, Science and Meteorological) and in 2018 a LCA dedicated to the ground segment will be carried out. These studies have given a very good overview of the hotspots (main areas of environmental impact). As a quantitative example, in terms of global warming potential, the life cycle of one launch of Ariane 5 is roughly equivalent to one passenger taking 25 000 return flights from Paris to New York.

The knowledge acquired from the output of these studies has enabled ESA to build a framework which will allow space actors to analyse their environmental impact in the most comprehensive and simple way.

The three main pillars of this framework are the following:
1. **ESSB Handbook:** guidelines on how to carry out an LCA in the space sector;
2. **ESA LCA Database:** contains space-specific LCA datasets to facilitate space LCA and understand the real environmental impact;
3. **EcoDesign Tool:** allows environmental protection to be integrated as a design criteria within Phase 0 studies at ESA.

Reach

Health and safety and environmental regulations such as REACH and RoHS affect the future availability of space related materials, processes, and consequently related technologies. Current estimates indicate that ca. 20% of space-applied materials may be affected in the long-term. Space programmes are exposed to a regulatory obsolescence risk due to legal obligations supporting the ban of non-authorised substances, as well as a commercial obsolescence risk as larger business sectors may drive the evolution of key markets to their needs, which are not neces-

sarily fit for purpose for space applications. The magnitude of the problem requires European-wide coordination allowing the identification of common risks and timely management of mitigating actions.
The early availability of sustainable solutions would represent a unique market opportunity, serving European industry with an advantage for global competitiveness.
Acting proactively now is therefore cheaper, less disruptive and vital to ensure the sustainability of space activities, and within EcoDesign different REACH-targeted activities are being carried out such as chromates replacement testing.
Since 2011, valuable knowledge has been gained on the environmental impacts of space and the risks posed by REACH. The next stage consists of moving to application, developing technologies that reduce the space sector's environmental impact and replace REACH-affected substances with the goal to ensure the long-term sustainability of the European space industry.

CLEANSAT

The objective of CleanSat is the maturation of the technologies to achieve full compliance with Space Debris Mitigation (SDM) requirements in a coordinated approach involving ESA, system integrators and subsystem and equipment manufacturers.
International guidelines applicable to future missions, state that at the end of their operational lifetime satellites and upper stages have to be passivated and removed from protected zones. This will require advancement in several technology fields. The different requirements and different technology solutions can be grouped as depicted in Figure 2.

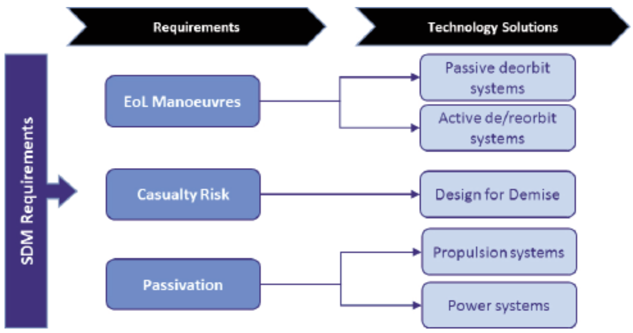


Figure 2 : SDM technology areas. Credit: ESA

Developing technologies to promote the systematic compliance of European missions with the SDM requirements has become a key objective of the Clean Space initiative. As such, many activities have been carried out over the last four years, falling within the following technology areas:

1. Deorbiting systems – Satellites shall be removed from LEO within 25 years after their End of Life; with high reliability, ideally without detracting from mission efficiency. If the design does not comply with the on-ground casualty risk limit, a controlled reentry should be performed. These deorbiting systems can be active (dedicated propulsive systems for attitude and orbit control) or passive (exploiting the atmospheric drag or using Earth's magnetic field).
2. Design for demise – The risk of casualty on ground of a reentering satellite or launch vehicle orbital stage shall not exceed 10^{-4}. To ensure this, spacecraft systems can make use of designs that demise upon reentry and make controlled re-entries unnecessary. The critical items identify are tanks, reaction wheels, optical payloads and magnetorquers.
3. Passivation - At the End of Life the satellite shall permanently deplete or make safe all stored energy, namely propulsion and power subsystems. The lack of passivation has been the main source of fragmentation events and new debris generation. Today, passivation operations are performed on a best effort basis by the satellite operators, therefore the efficacy of passivation solutions requires further activities.
4. Design for servicing – Standardised features to be incorporated on future satellites to enable active debris removal or orbital servicing missions. Even with full compliance to the SDM requirements, 10% of satellites launched in the future may remain in orbit. These satellites will need to be removed, and hence innovative technologies (such as retroreflectors, markers patterns, capture interface points, etc.) could be implemented.
In 2016, 28 different building blocks (studies), concerning the technologies areas mentioned before, were investigated in a concurrent approach in which Large System Integrators and suppliers were involved. Other studies (i.e. testing of deorbiting sails and materials for design for demise) were also performed in parallel.
During this phase, the integrators highlighted the necessity of an urgent upgrade of the LEO platforms to make them compliant with the SDM requirements.
The next phase aims now at maturing the high-priority technologies for integration within future LEO platforms – for controlled and uncontrolled reentry as well as for passivation devices (i.e. demisable propulsion tanks, arcjets, etc.).
The necessity of preserving the Earth's orbital environment as a safe zone free of debris is an increasingly important driver for the selection of space programmes. The only way to control the debris population across key low orbits is to remove objects with high mass, high collision probabilities, at high altitudes, by performing Active Debris Removal (ADR).
ESA's Clean Space initiative is studying an active debris removal mission called e.Deorbit (Figure 3), which will target an ESA-owned derelict satellite in low orbit, capture it, and

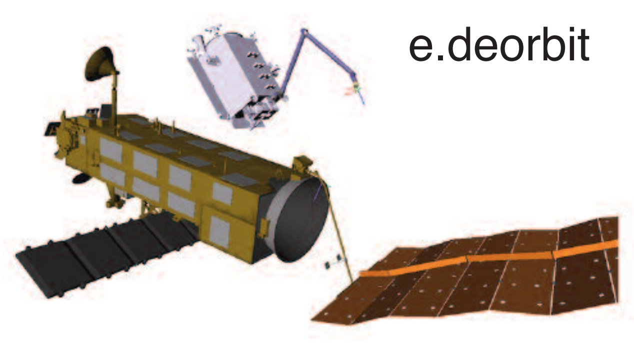


Figure 3: e.Deorbit. Credit: ESA

then safely burn it up in a controlled atmospheric reentry. e.Deorbit will be the world's first active debris removal mission, and will provide an opportunity for European industries to showcase their technological capabilities to a global audience.

The main technical challenge the mission will face is to capture a massive, drifting object left in an uncertain state, which may well be tumbling rapidly. Sophisticated imaging sensors and advanced autonomous control will be essential, first to assess its condition and then approach, capture and deorbit it.

In the past few years, industries worldwide have been studying and promoting “space tugs”, i.e. vehicles able to perform several services bringing space utilisation a step further. Among these services, in-orbit servicing, active debris removal, and space transportation are the most promising ones. Industries attach a high commercial interest to such vehicles and competition on different concepts is ongoing.

All key technologies studied within the e.Deorbit mission will be a key factor to enable space tug developments. A considerable amount of advances have already be made in the following fields:

- **Innovative robotics and capturing mechanisms** have being studied in order to minimise the mission risk. After various system studies, two promising capture techniques are under development throw-nets (applicability to debris because of scalability to capture a large target) throw a robotic arm, with a gripper (it has the capability to capture appendages on spacecraft).

- **Advanced image processing systems** are required to enable the extraction of dynamical and kinematical properties of the object. This will be performed on the inputs from sensors such as a LIDAR, multispectral camera, visual camera, and also within the visual serving system of the robotic arm.

- **Complex Guidance Navigation and Control (GNC)** drives the need for intricate control algorithms which are fundamental to take the inputs from the image processing and, from this, actuate the spacecraft to ensure a safe and controlled synchronised approach to rendezvous with the debris whilst minimising the risk of collision.

The proposed activities for the Maturation Phase comprise:

- **Deorbit Preliminary Definition Phase:** involving work to enhance the system design, with particular emphasis on communications, on-board autonomy, processing, control algorithms, accommodation of GNC and robotic equipment and the development of risk mitigation strategies, cost estimates and the master mission schedule.

- **e.Deorbit Robotics Subsystem:** To develop the key robotic technologies required for a robotic debris removal mission such as the robotic gripper, clamping mechanism, robotic arm, visual servoing system, and the capture and robotic control algorithms together with the associated test beds
- **Deorbit GNC Subsystem:** developing a LIDAR, a far range and close range camera, multispectral camera, infrared camera, 3-DOF camera together with the image recognition and processing for the selected sensor suite and the associated payload computer based on these processing demands.

- **Deorbit Net Subsystem:** working on the key technologies required for a debris removal mission using a net, including verification and validation through a sounding rocket test.

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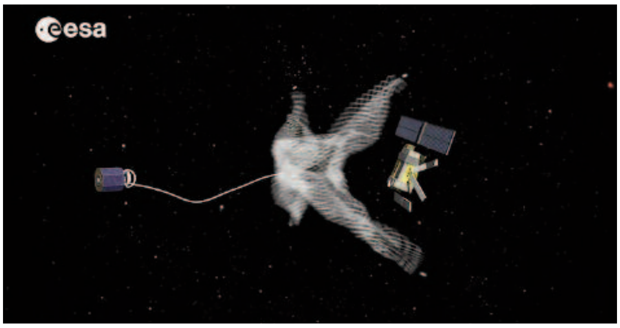
Robotic Arm Capture of Large Debris



Net Capture of Large Debris

ESA CUBESAT NANO-SATELLITE MISSIONS FOR TECHNOLOGY IN-ORBIT DEMONSTRATION

Dr. Roger Walker FRAeS, ESA/ESTEC, Systems Engineer, Systems Department (Roger.Walker@esa.int)

WHAT ARE CUBESATS?

CubeSats are a type of small satellite invented by Prof. Bob Twiggs (Stanford University) and Prof. Jordi Puig-Sari (California Polytechnic) in the early 2000s as an affordable and fast means to give hands-on engineering training to university students. Originally built around a stack of PC/104 electronics boards of 10x10 cm, the first CubeSats were of standardised external cubic unit dimensions (10x10x10 cm) and launched inside a container which released the CubeSats on rails by using a simple spring loaded pusher plate. Since then, CubeSats of multiple units (and their deployers) have been developed and flown, ranging from 2-units (or "2U"), to 3U, 6U and more recently 12U (see Fig. 1 for typical dimensions and masses). Now, 16U and 27U CubeSats are also being designed. Generally, CubeSats have grown in size over the years in order to accommodate more equipment for higher performance and more resources for larger/more power consuming payloads as they transition to operational utility. They extend in mass from the pico-satellite class (<1 kg), to the nano-satellite class (<10 kg) up to the microsatellite class (<100 kg).

WHY CUBESATS?

Beyond the education domain, CubeSats have been widely adopted worldwide not only by academia/research institutes for technology and scientific research, but also government agencies and commercial operators for real mission applications. A number of factors have led to CubeSats becoming popular. They exploit an extensive spin-in of terrestrial Commercial Off The Shelf (COTS) components, sensors and other miniaturised technologies that are then qualified for space use, making them easy to produce in volume at low cost. Their standard size and low mass, combined with their launch inside a rigid container, ensures that there is a high availability of low-cost piggy-back launch opportunities on many different launch vehicles. Therefore, a significant reduction in the entry level cost of space activities is achieved, allowing more actors to develop and carry out space activities than ever before. Typically, the on-board equipment has standard mechanical, electrical and data interfaces, thereby speeding up the Assembly, Integration and Verification (AIV) process, and environmental testing can be carried out in small facilities. In turn, this allows CubeSats to have short satellite development schedules (typically 1-2 years) thus enabling rapid in-orbit demonstration of new technologies. Due to the standardisation, there is a high availability of different products & developer support in the industrial supply chain and whole new eco-system has developed with new players entering the market continuously.

CUBESAT EVOLUTION IN EUROPE

The emergence of CubeSats in the European space sector has evolved organically in a similar way to other parts of the world, e.g. USA and Japan. Particularly over the last decade, university CubeSat projects have spun off new start-ups and Small, Medium Enterprise (SME) companies, and today there are a large number of CubeSat system integrators, platform/product suppliers and launch/operations service providers active in Europe (over 120 companies today). As can be seen in Figure 2, the evolution of CubeSats can be characterised in three waves. The first wave is educational, and this is expected to continue in future. We are now in the second wave where missions are focussed on technology demonstration in order to prepare CubeSat for future operational use in the third wave, where three different branches are expected in the near future: constellations in Low Earth Orbit for commercial remote sensing/telecom applications (note: this has already started in USA with the deployment of the Planet and Spire constellations), close proximity operations (e.g. swarm formation flying, rendezvous & docking, close inspection), and science missions beyond Low Earth Orbit (e.g. space weather monitoring, lunar/Near Earth Object characterisation) either as stand-alone missions or as carry-along passengers on larger missions.

CUBESATS AND IN-ORBIT DEMONSTRATION

In the ESA context, CubeSats can effectively serve several technology In-Orbit Demonstration objectives: to act as a driver for drastic miniaturisation of systems; an opportunity to demonstrate innovative technologies in orbit at a low cost and fast pace; an opportunity to carry out distributed in-situ measurements of the space environment simulta-

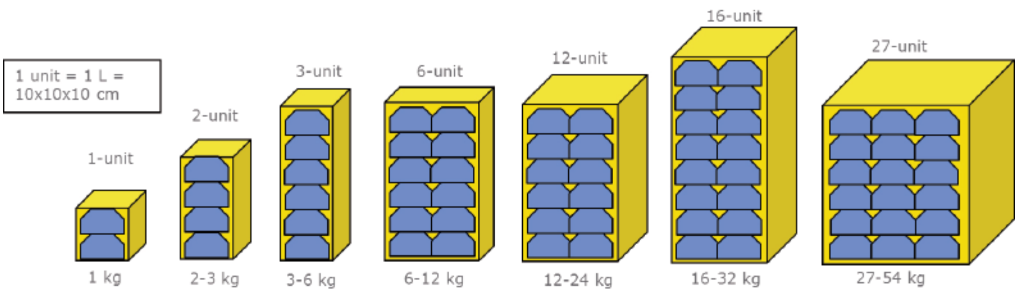


Figure 1 – illustration of different CubeSat sizes and masses

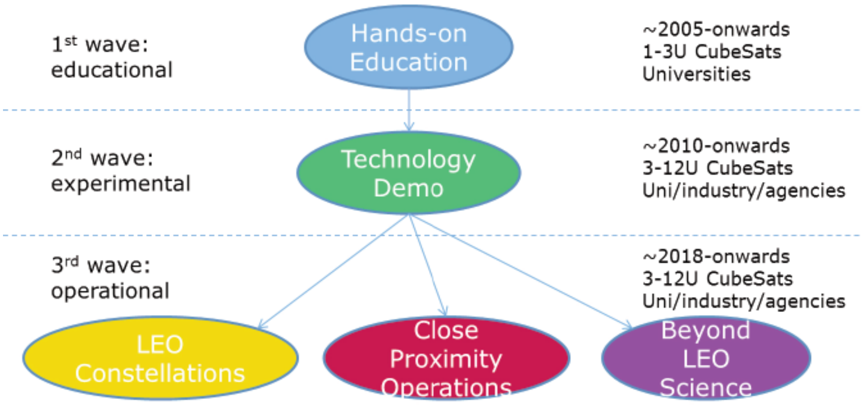


Figure 2 – CubeSat evolutionary tree in Europe

deliver the CubeSat for deployment from the International Space Station (ISS) by Danish ESA astronaut Andreas Mogensen during his short duration mission. The CubeSat was accepted by ESA for flight and delivered on time to Nanoracks in Houston, and was then launched (along with another Danish CubeSat AAUSAT-5) to ISS on 19 August 2015 in the Japanese HTV-5 cargo vehicle on the H-II launcher. Unfortunately, Andreas Mogensen did not have the opportunity to deploy the CubeSat during his mission, but GOMX-3 was deployed from ISS on 5 October 2015 and remained in orbit until re-entry on 18 October 2016, successfully completing its IOD mission (see Figure 4 for a picture of the ISS deployment). The mission had a number of notable achievements: 3-axis stabilised attitude control with reaction wheels, rapid downlink of telemetry to ground at X-band (with a CNES funded transmitter developed by Syrlinks), use of reconfigurable software defined radio for analysis of GEO telecom satellite spot beams in L-band, and reception of ADS-B tracking data broadcast by aircraft. The ADS-B receiver was reconfigured during the mission to provide UK Met Office with additional data allowing them to derive absolute wind data globally from air traffic as an input to numerical weather prediction models.

neously; and the potential to deploy small payloads in a constellation or swarm system, where the potential deficit in performance may be largely compensated by the multitude of satellites. IOD CubeSats activities at ESA began in 2012 as part of the Technology Flight Opportunities element of the General Support Technology Programme (GSTP). Since then, seven IOD CubeSat projects have been initiated and funded to completion with a total budget of over 10 MEuro. Of these projects, one IOD CubeSat has been flown, one is ready for flight awaiting launch, three are being integrated, and the other two are in development. In addition to this, a number of CubeSat-related technology pre-development activities have been completed, initiated or planned within GSTP in order to support industrial competitiveness in this dynamic sector. These projects & activities involve research institutes and SMEs from 12 ESA Member States (see Figure 3).

GOMX-3: ESA'S FIRST IOD CUBESAT MISSION

ESA's first technology IOD CubeSat mission was GOMX-3, developed by Danish nano-satellite specialist Gomspace, with the objective to demonstrate a number of platform subsystems enabling enhanced performances from a 3U CubeSat. The project went from kick-off to flight readiness in 1 year: a very fast development driven by the need to

GOMX-4B: DEMONSTRATING CONSTELLATION TECHNOLOGIES

The success of the GOMX-3 mission led to the initiation of follow-on project with Gomspace called GOMX-4B in late 2015, aimed at demonstrating more advanced platform technologies enabling the rapid deployment and networked operation of future CubeSat constellations. GOMX-4B is a 6U CubeSat with the main IOD mission objectives to demonstrate along-track station acquisition/keeping manoeuvres using on-board cold gas propulsion (developed by Nanospace in Sweden) and Inter-satellite link com-

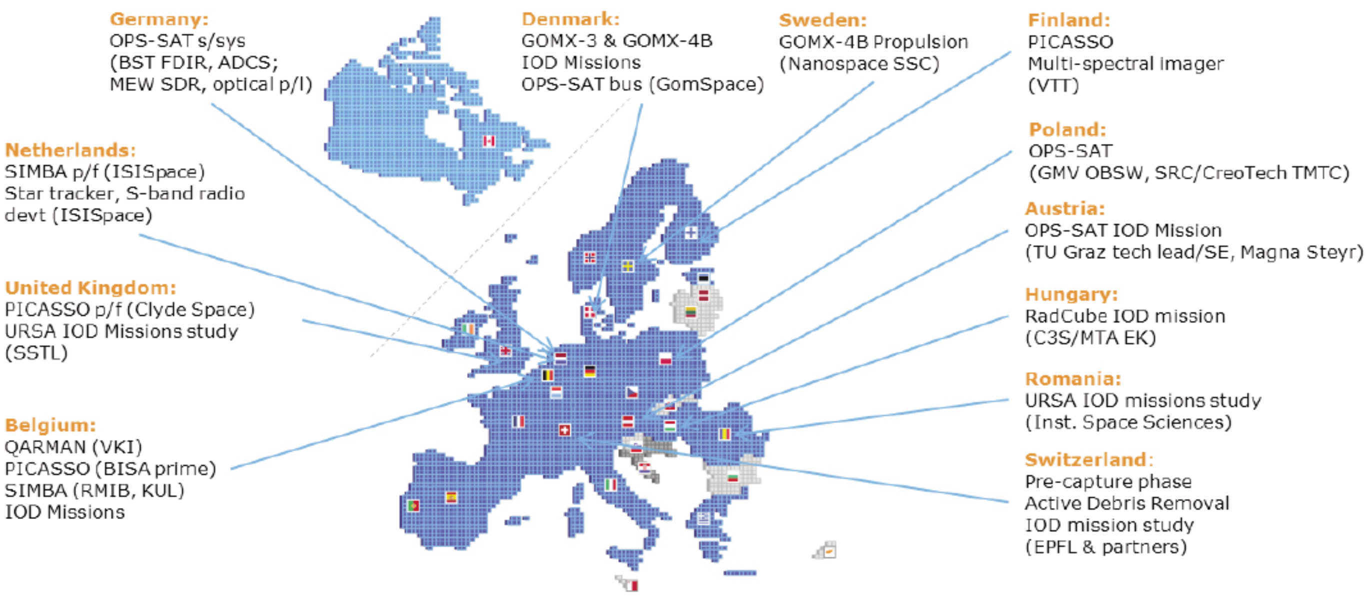
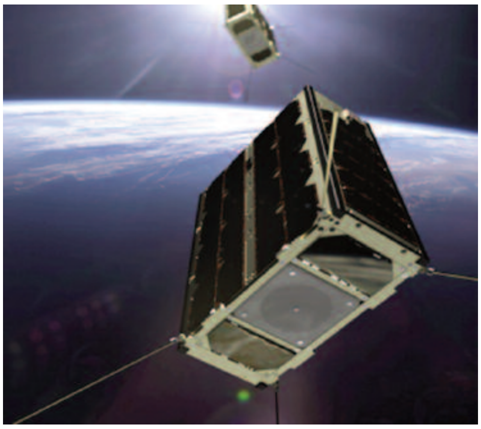


Figure 3 – Participation of ESA Member States in ESA CubeSat activities

Figure 4 – Picture of GOMX-3 (above) being released from the Nanoracks deployer on ISS along with AAUSAT-5 (below). Credit: Nanoracks/NASA.



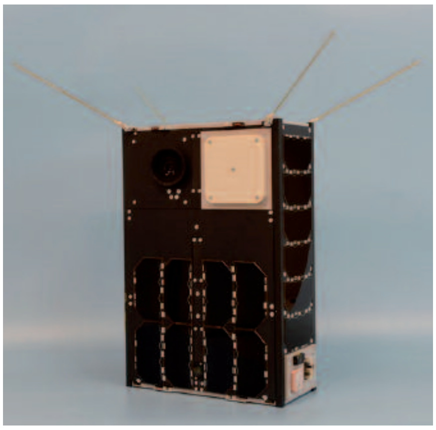


Figure 5 – Illustration of GOMX-4A and 4B in flight (left) and picture of the flight ready GOMX-4B (right). Credit: Gomspace.

munications using an S-band software defined radio (developed by GomSpace) at distances up to 4500 km along track. The satellite is planned to be launched and operated in tandem with GOMX-4A, another 6U CubeSat developed by Gomspace for the Danish Ministry of Defence. The larger size of GOMX-4B allowed a number of third party payloads to be accommodated, including the HyperScout hyperspectral imager (developed in GSTP by Cosine in The Netherlands), a new Star tracker for precise pointing (developed in GSTP by ISISpace in The Netherlands), and a Radiation Hardness Assurance experiment (developed in house at ESA/ESTEC) to test new EEE components in space (Figure 5). The flight readiness of the GOMX-4B satellite was achieved on time in July 2017 and the satellite accepted for flight by ESA. The launch of the two GOMX-4 satellites was planned on the Chinese Long March 2D in September 2017, but the launch has been recently postponed until February 2018.

ESA IOD CUBESATS IN DEVELOPMENT

A number of ESA IOD CubeSat projects are currently ongoing in various stages of development (see Table 1 for an overview). They are focussed on demonstration of a diverse range of payload and platform technologies, as well as end user applications ranging from space weather monitoring to atmospheric/climate science and re-entry research. The CubeSats are developed by industrial/research institute consortia to an ESA-defined project lifecycle, tailored ECSS engineering standards and product/quality assurance requirements, and ESA performs the technical and quality management of the projects via project reviews & specialist support, as well as providing access to test facilities.

ESA ROADMAP FOR FUTURE IOD CUBESAT MISSIONS

Based on past and ongoing mission concept studies conducted in the frame of the ESA General Studies Programme, an ESA IOD CubeSat missions roadmap has been defined and presented to ESA Member States. These are intended to be ESA-driven missions put out for open competitive tender amongst the countries providing funding support to specific projects. As previously, Industry-driven IOD CubeSat missions can be proposed to ESA at any time for evaluation under a separate framework in GSTP. The overall plan out to 2021 for the ESA-defined roadmap is shown in Figure 6, overlapping with the past/present projects which have all been industry-driven missions. They are focussed on constellation pre-cursors (high-resolution NO_2 imaging, GNSS-R and RO) as well as breakthrough missions for close proximity operations (Rendezvous & Docking for demonstration of on-orbit assembly) and enabling CubeSats to venture out into highly elliptical Earth orbit, lunar and deep space for the first time.

PROJECT	IOD MISSION	PLATFORM	PAYLOADS	STATUS
QARMAN	Re-entry research & tech demo	3U	Spectrometer for in-situ re-entry plasma analysis; Temperature, pressure, strain sensors	Satellite integrated for flight, testing ongoing Launch in Q2 2018
PICASSO	Stratospheric Ozone & Mesospheric Temperature profiles via solar occultation measurements; Ionospheric Electron density in-situ measurements	3U	VISION multi-spectral imager with Fabry-Perot Interferometer; Sweeping Langmuir Probe	Flight model in production Launch in Q4 2018 to SSO <600 km (Vega SSMS flight)
SIMBA	Total Solar Irradiance, Earth Radiation Budget measurements; Precision 3-axis pointing demo	3U	Absolute cavity radiometer; 3-axis ADCS with star tracker & reaction wheels	Flight model in production Launch in Q4 2018 to SSO <600 km (Vega SSMS flight)
OPS-SAT	Demonstration of new operations technologies and techniques	3U	Powerful fully reconfigurable FPGA to implement new CCSDS application interfaces: MO Services and file transfer protocol; S-band transceiver; optical uplink	Post CDR, Launch 2019
RadCube	In-situ Radiation environment & and techniques Magnetic field monitoring for future space weather services; robust/reliable CubeSat platform; Characterisation of Radiation effects on EEE components	3U	RadMag including electron/ proton/cosmic ray particle detector, magnetometer on extendable boom; Radiation Hardness Assurance experiment	Phase B2 ongoing, PDR in December 2017 Launch: Q4 2019 to SSO <600 km

Table 1: Overview of IOD CubeSat projects currently in development

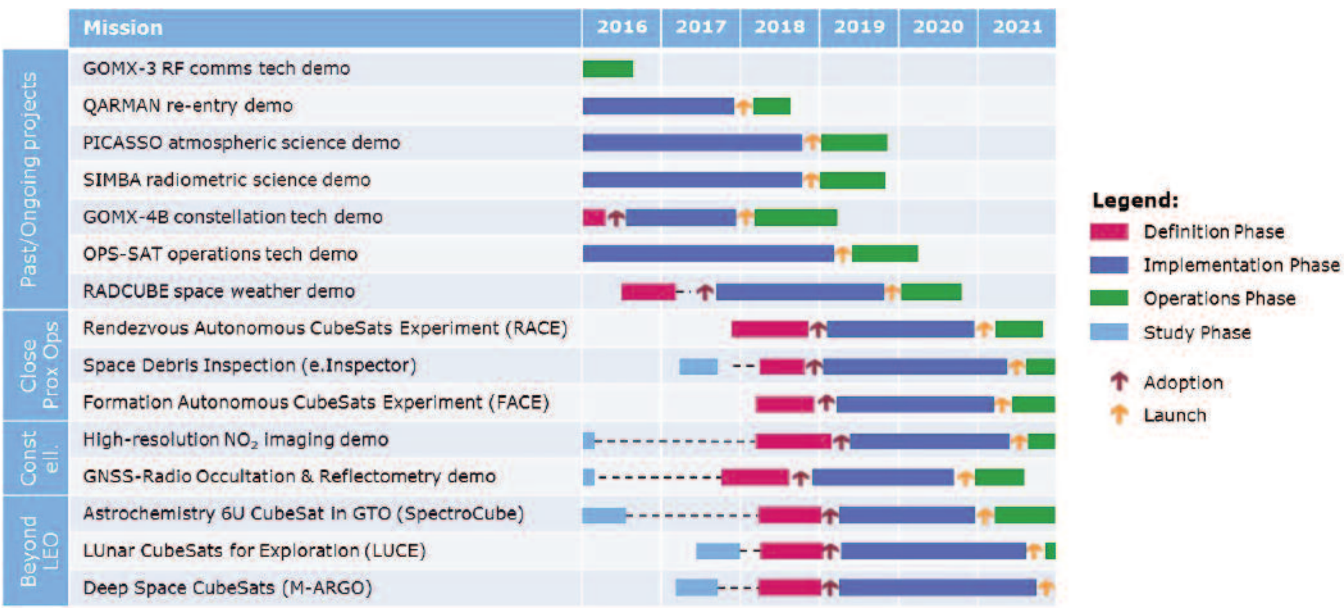


Figure 6 – ESA IOD CubeSat missions roadmap to 2021

2 JUNE 2017: RETURN TO THE EARTH OF THOMAS PESQUET AFTER HIS LONG-DURATION PROXIMA MISSION ON BOARD OF THE ISS

By Jean-Pierre Sanfourche

On 2 June 2017, ESA astronaut Thomas Pesquet landed on the steppe of Kazakhstan with Commander Oleg Novitsky in their Soyuz MS-03 spacecraft after six months in space on board of the International Space Station (ISS). Thomas's mission was called Proxima whose science was the most important part. Taking part in a very high number of experiments, he set a record for the number of hours spent on science in a week as part of an Expedition crew.
The present article provides a glimpse of this quite successful and important mission.

Thomas Pesquet was born in Rouen, France, on 27 February 1978.
In 2001, he received Master's Degree from SUPAERO (France), majoring in spacecraft design and control. He spent his final year before graduation at the Ecole Polytechnique de Montréal (Canada) as exchange.
In 2006, he graduated from the Air France Flight School obtaining an Air Transport License Instrument Rating (ATL-IR).
Selected as an ESA astronaut in May 2009, he joined ESA in September 2009, becoming the Benjamin of the European Astronauts Corps.
On 17 March 2014, he was assigned to be on long-duration mission on the ISS.

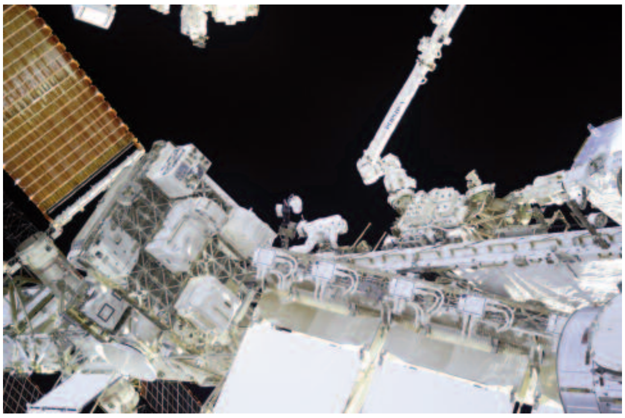
PROXIMA MISSION : KEY DATES

- **17 November 2016 at 19h20 GMT:** Proxima liftoff. European Thomas Pesquet, NASA astronaut Peggy Whitson and Roscosmos cosmonaut Oleg Novitsky are launched to the ISS from Baikonur cosmodrome in Kazakhstan on their Soyuz MS-03 spacecraft.
- **17 November 2016 at 20h28 GMT:** spacecraft separation.
- **19 November 2016 at 21h02 GMT:** docking to the ISS.
- **20 November 2016 at 00h15 GMT:** hatch opening.

Proxima liftoff @ ESA

17 November 2016 at 19h20 GMT : Proxima liftoff from Baikonur cosmodrome (Kazakhstan)

- **13 January 2017:** first spacewalk. Thomas Pesquet completed his first spacewalk together with NASA astronaut Shane Kimbrough. The duo spent 5 hours and 58 minutes outside the ISS to complete a battery upgrade to the outpost's power system (replacement of nickel-



Thomas Pesquet space walker © ESA

hydrogen batteries that store electricity from the ISS's solar panels (2500 sq m) with newer lithium-ion batteries) and then to perform a number of extra tasks.
- **27 March 2017:** second spacewalk. **Thomas Pesquet** and NASA astronaut Shane Kimbrough spent 6 hours and 34 minutes working on upgrading the ISS's computer sys-

Thomas second spacewalk

Thomas back on Earth

Thomas and Oleg back on Earth
© ESA–Stephane Corvaja, 2017
ESA astronaut Thomas Pesquet landed on the steppe of Kazakhstan with Russian commander Oleg Novitsky in their Soyuz MS-03 spacecraft on 2 June 2017 after six months in space. Touchdown was at 14:10 GMT after a four-hour flight from the International Space Station.

General view of the European Astronaut Centre (EAC), Linder Höhe, Cologne (Germany) © ESA

tems, replacing lights, checking for leaks in the cooling system and maintaining the Dextre robotic hand. Thomas and Shane worked separately throughout their sortie.

- **2 June 2017 at 07h31 GMT:** hatch closing.
- **2 June 2017 at 14h10 GMT:** Thomas Pesquet landed on the steppe of Kazakhstan with Russian commander Oleg Novitsky in their Soyuz MS-03 spacecraft.

Touchdown was at 14h10 GMT after a four-hour flight from the ISS: the co-called "routine" ride that requires braking from 28 800 km/h to zero, the heat shield having to cope with the 1600°C as the spacecraft enters the atmosphere at an altitude of about 100 km. Reentry begins at 100 km, when the sped at which the capsule travels is reduced dramatically and the crew is pushed back into their seats feeling forces up to 5g. Then for landing, parachutes deploy to reduce speed even more and the astronauts sit in custom-fitted seats with shock absorbers that reduce the shock at impact. At the last moment, retrorockets fire before touchdown to limit the landing speed to about 5 km/h.
Immediately after landing, Thomas Pesquet was flown back to the European Astronaut Centre in Cologne (Germany), the home base of all ESA astronauts. This early access of Thomas Pesquet allowed ESA's medical team to monitor his health very closely and to start his fitness and rehabilitation programme quickly. Scientists also benefit from continuing with their scientific examinations.

EUROPEAN SCIENCE: 62 EXPERIMENTS COORDINATED BY ESA AND CNES

During his 6-month mission onboard the International Space Station, Thomas Pesquet contributed to the operation of 62 experiments coordinated by ESA and CNES covering human a broad spectrum of research subjects: Biology - Plants – The Seedling Growth-3 analyses how plants react to coloured light sources in microgravity.

- **Biology** - Plants – The Seedling Growth-3 analyses how plants react to coloured light sources in microgravity.

- **Material Science and Physics.**
  – Metals - Investigation of the effects of microgravity on microstructures, especially on liquid metals when forming alloys.
  – Plasma - Creation of plasma-micro particles in micro-

gravity to simulate how molecules interact in 3 dimensions.
- Fluids - Measurement of diffusion in liquid mixtures and analysis of fluids' behaviour under microgravity – in particular, at the slosh of liquid propellants in reservoirs during satellite manœuvres.

- **Monitoring space environment.**
  - Sun - The SOLAR facility measures the Sun's electromagnetic radiation with unprecedented accuracy across a wide part of its spectral range.
  - Radiation - The DOSIS-3D experiment monitors radiation in the European Columbus module to prevent health problems on long-duration missions.
  - Magnetic field - The MagVector experiment measures changes in the strength of the magnetic field that interact with the ISS to better understand the effects of Earth's magnetic field on electrical systems.

- **Human Research:**
  - Head - Thomas's head is examined in detail before and after the mission to understand how the neural process of perception adapts to weightlessness.
  - Hands - The GRIP experiment studies the effects of long-duration spaceflights on Thomas's dexterity. The GRASP experiment takes advantage of the Perspective experiment to immerge Thomas in a virtual-reality environment. The goal is to investigate how the central nervous system integrates sensory cues and information to coordinate hand movement and visual perception.
  - Inner clock – The Circadian Rhythms experiment aims to study how long-duration spaceflight affects Thomas's biological clock.
  - Metabolism – Humans lose body mass in space. Thomas measures changes in energy expenditure to derive an equation for an astronaut's needs on long-duration missions to the ISS and beyond.
  - Bones - The Early Detection of Osteoporosis in Space experiment looks at changes in astronaut's bone structure.
  - Muscles - Study of muscles' characteristics that are particularly affected in space (SARCOLAB-3 experiment) and study of how muscles perform before and after the long-duration flight by taking samples of Thomas Pesquet's soft tissue before and after the mission (Muscle Biopsy experiment).
  - Skin - The aim of the Skin-B experiment is to gain insights on skin physiology in space, and in particular the skin-ageing process.
  - Immune system - More than half of space travelers show significant signs of immune dysfunction after long-duration missions. The Immune-2 experiment looks at how stress affects the immune system.

- **Technology Demonstrations:**
  - Water purification - Tests of filter capabilities of a membrane in microgravity and analysis of microbial quality of ISS's water (Aquamembrane demonstration) and detection of microbes in a potable water sample in space (Aquapad experiment).
  - Cleaning up - Reduction of surface microbial contamination in astronaut spacecraft (MATISS experiment).
  - Feel the force - Investigation of the limits of human perception and ability to appliy fine forces with their limbs and hands in space (Haptic/Interact experiment)
  - Remote Control - Experiment (Meteron SUPVIS-E) helping turn robotics and remote operations into a standard tool for future space missions (operation of ESA's Eurorobot in the NL while orbiting Earth using a laptop and a joystick) and test of a medical imaging ultrasound scanner remotely operated by a radiologist on Earth (Echo unit).
  - Suited for space - Test of a suit designed to combat the lack of gravity effects by squeezing the body from shoulders to the feet with a familiar force to that felt on Earth (Skinsuit).
  - Smart sensors - Clothing that incorporates sensing devices (EveryWear) demonstrates how personal physiological data can be collected from astronauts and transmitted in real time for medical and scientific purposes. EuCPAD project tests a new radiation dosimetry system for space that can provide continuous, real-time information about radiation exposure and could become part of ESA's radiation protection strategy for astronauts.
  - Wireless sensors technology - The Wise-Net experiment is testing a set of sensors.
  - Maritime control - The Vessel ID system is attached to the Columbus laboratory; its satellite receiver can identify more than 22 000 ships a day.

N.B. - Thomas Pesquet did not only contribute to European science because in addition to those 62 experiments, he took part in addition to 55 other experiments from non-European nations.

SCIENCE RECORD SET ON A SPACE STATION

The astronauts of Expedition 50 have set a new record for most time spent on scientific research on the ISS.

In the only week of 6 March, Thomas Pesquet, NASA astronauts Shane Kimbrough and Peggy Whitson, and cosmonauts Oleg Novitsky, Andrei Borisenko and Sergei Ryzhikov clocked a combined 99 hours of science: a new record for most time spent on scientific research on the ISS!

AMONG UPCOMING AEROSPACE EVENTS

2017

02-06 October • **ESA** – 7th International Symposium on Physical Science in Space and 25th European Low Gravity Research Association Symposium – Juan-les-Pins (France) – www.esa.int

03-05 October • **Aviation Week** – MRO Europe 2017 – London (UK) – Excel London – www.mroeurope.aviationweek.com/

10-11 October • **AAE** – International Conference "The Climate Needs Space" – Toulouse (France) – Congress Centre Météo – France – www.academie-air-espace.com/espaceclimat

11-12 October • **3AF** – Propriété Intellectuelle et Innovation – Strasbourg (France) – www.p2i2017.com

11-12 October • **EDA** – EDA annual Military Airworthiness Conference (MAC) 2017 – Athens (Greece) – Hellenic Armed Forces Officer's Club – https://www.eda.europa.eu/info-hub/events

16-20 October • **CEAS** – CEAS Aerospace Europe 2017 Conference – 6th CEAS Conference – Bucharest (Romania) – Parliament of Romania – www.ceas2017.org

23-25 October • **FSF**– IASS 2017 – 70th annual International Air Safety Summit – Dublin (Ireland) https://flightsafety.org/summit-seminar/

24-26 October • **RAeS** – Reinventing Space Conference – Glasgow, Scotland (UK) – Strathclyde University and Innovation Centre – www.rispace.org

25-27 October • **ESA** – 6th international Colloquium on Scientific and Fundamental Aspects of GNSS/Galileo – Valencia (Spain) – TU Valencia – http://esaconferencebureau/list-of-events

31 October – 1 November • **RAeS** – European Airline Training Symposium (EATS) – Verlin (Germany) – Estrel Hotel Berlin – www.aerospace.com/events

07-08 November • **SESAR JU** – Digitalizing Europe's Aviation Infrastructure – Tallinn (Estonia) http://www.sesarju.eu/events

13-15 November • **IAA** – 1st International Academy of Astronautics (IAA) Conference on Space Situational Awareness – Orlando, FL (USA) – www.icssa2017.com

21-22 November • **ESA** – Space Engineering and Technology Final Presentation Days – Noordwijk (NL) ESA/ESTEC – www.esa.int

28 November - 30 November • **SESAR JU** – 7th SESAR Innovation Days – Belgrade (Serbia) – University of Belgrade http://www.seasrju.eu/events

29-30 November • **ICAO** – Seminar on Green Airports – Montréal (Canada) – ICAO/HQ – https://www.icao.int/Meetings

05-07 December • **ACI EUROPE** – 11th ACI Airport Exchange – Mucat, Oman – www.airport-exchange.com/

06-07 December • **EUROCONTROL** – Surveillance Info Days – Brussels (Belgium) – Eurocontrol/HQ – Rue de la fusée 36 www.eurocontrol.int/events

AMONG UPCOMING AEROSPACE EVENTS

2018

08-12 January • **AIAA** – AIAA SciTech Forum and Exposition: AIAA/AHS Adaptive Structures Conf. – AIAA Aerospace Sciences Meeting – AIAA Atmospheric Flight Mechanics Conf. – AIAA Information Systems Infotech Conf. – AIAA GNC Conf. – AIAA Modeling and Simulation Technologies Con. – AIAA Non-Deterministic Approaches Conf. – AAS.AIAA Space Flight Mechanics Conf. – AIAA/ASCE/AHS/ASC Ctrustures and Materials Conf. – AIAA Spacecraft Structures Conf. – Wind Energy Conf. - Orlando, FL (USA) – www.aiaa.org/events

31 January – 02 February • **3AF** – ERTS (Embedded Real Time Software and Systems) Conference – Toulouse (France) – www.erts2018.org

06-08 February • **3AF** – 8th International Symposium on Optronics in Defence and Security – Paris (France) – www.optro2018.org

06-11 February • **Singapore Airshow** – Changi Exhibition Centre – Singapore – www.singaporeairshow.com/

06-08 March • **CANSO/ATCA** – World ATM 2018 – IFEMA, Feria de Madrid – 28042 Madrid (Spain) http://www.worldatmcongress.org/201

26-28 March • **3AF** – 53rd International Conference on Applied Aerodynamics – AERO2018 – Salon de Provence (France) - Ecole de l'Air – www.3AF-aerodynamics2018.com

25-29 April • **BDLI** – ILA Berlin 2018 – ExpoCentre Airport – Schönefeld – Berlin (Germany) – https://www.ila-berlin.de/

08-10 May • **AIAA** – AIAA DEFENSE Forum – Laurel, MD (USA) – www.aiaa.org/events

28-30 May • 25th Saint Petersburg International Conference on Integrated Navigation Systems – Saint Petersburg (Russia) www.elektropribor.spb.ru

28 May – 1 June • SpaceOps 2018 – Marseille (France) – www.spaceops2018.org

29-31 May • **EBAA/NBAA** – EBACE 2018 – European Business Aviation and Exhibition – Geneva (Switzerland) – Geneva's Palexpo – http://ebace.aero/2018/

25-29 June • **AIAA** – AIAA Aviation and Aeronautics Forum and Exposition – Atlanta, GA (USA) – www.aiaa.org/events

09-11 July • **AIAA** – AIAA Propulsion and Energy Forum and Exposition – Cincinnati, Ohio (USA) – www.aiaa.org/events

16-22 July • Farnborough International Airshow 2018 – International Exhibition and Conference Centre – Farnborough, Hampshire (UK) – https://www.farnboroughairshow.com/

19-23 August • **AAS/AIAA** – Astrodynamics Specialist Conference – Snowbird, UT (USA) – http://www.space-flight.org

27-29 August • **AIAA** – AIAA Space and Astronautics Forum and Exposition – New Orleans, LA (USA) – www.aiaa.org/events