CEAS
Council of European Aerospace Societies

BULLETIN AEROSPACE EUROPE

EUROPEAN UNION SATELLITE CENTRE
SatCen
Analysis for decision making

THE EU SATELLITE CENTRE

WORKING FOR EU'S COMMON FOREIGN AND SECURITY POLICY

INTERVIEW WITH PASCAL LEGAI, DIRECTOR OF THE EU SATELLITE CENTRE

CEAS

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

It was established as a legal entity conferred under Belgium Law on 1st of January 2007. The creation of this Council was the result of a slow evolution of the 'Confederation' of European Aerospace Societies which was born fifteen years earlier, in 1992, with three nations only at that time: France, Germany and the UK.

It currently comprises:

- 12 Full Member Societies: 3AF (France), AIAE (Spain), AIDAA (Italy), AAAR (Romania), CzAeS (Czech Republic), DGLR (Germany), FTF (Sweden), NVvL (The Netherlands), PSAA (Poland), RAeS (United Kingdom), SVFW (Switzerland) and TsAGI (Russia);
- 4 Corporate Members: ESA, EASA, EUROCONTROL and EUROAVIA;
- 8 Societies having signed a Memorandum of Understanding (MoU) with CEAS: AAE (air and Space Academy), AIAA (American Institute of Aeronautics and Astronautics), CSA (Chinese Society of Astronautics), EASN (European Aeronautics Science Network), EREA (European association of Research Establishments in Aeronautics), ICAS (International Council of Aeronautical Sciences), KSAS (Korean Society for Aeronautical and Space Sciences) and Society of Flight Test Engineers (SFTE-EC).

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

AEROSPACE EUROPE

Besides, since January 2018, the CEAS has closely been associated with six European Aerospace Science and Technology Research Associations: EASN (European Aeronautics Science Network), ECCOMAS (European Community on Computational Methods in Applied Sciences), EUCASS (European Conference for Aeronautics and Space Sciences), EUROMECH (European Mechanics Society), EUROTURBO (European Turbomachinery Society) and ERCOFTAC (European Research Community on Flow Turbulence Air Combustion).

Together those various entities form the platform so-called 'AEROSPACE EUROPE', the aim of which is to coordinate the calendar of the various conferences and workshops as well as to rationalise the information dissemination.

This new concept is the successful conclusion of a work which was conducted under the aegis of the European Commission and under their initiative.

The activities of 'AEROSPACE EUROPE' will not be limited to the partners listed above but are indeed dedicated to the whole European Aerospace Community: industry, institutions and academia.

WHAT DOES CEAS OFFER YOU ?

KNOWLEDGE TRANSFER:

- A structure for Technical Committees

HIGH-LEVEL EUROPEAN CONFERENCES:

- Technical pan-European events dealing with specific disciplines
- The biennial AEROSPACE EUROPE Conference

PUBLICATIONS:

- CEAS Aeronautical Journal
- CEAS Space Journal
- AEROSPACE EUROPE Bulletin

RELATIONSHIPS AT EUROPEAN LEVEL:

- European Parliament
- European Commission
- ASD, EASA, EDA, ESA, EUROCONTROL, OCCAR

HONOURS AND AWARDS:

- Annual CEAS Gold Medal
- Medals in Technical Areas
- Distinguished Service Award

YOUNG PROFESSIONAL AEROSPACE FORUM

SPONSORING

AEROSPACE EUROPE Bulletin

AEROSPACE EUROPE Bulletin is a quarterly publication aiming to provide the European aerospace community with high-standard information concerning current activities and preparation for the future.

Elaborated in close cooperation with the European institutions and organisations, it is structured around five headlines: Civil Aviation operations, Aeronautics Technology, Aerospace Defence & Security, Space, Education & Training and Young Professionals. All those topics are dealt with from a strong European perspective.

Readership: decision makers, scientists and engineers of European industry and institutions, education and research actors.

EDITORIAL COMMITTEE

Editor-in Chief: Jean-Pierre Sanfourche
sanfourche.jean-pierre@orange.fr
Deputy Editor-in-Chef: Pierre Bescond (CEAS VP External relations)
Committee's Members: Rafael Bureo-Dacal (ESA/ESTEC), Georges Bridel (CEAS Trustee), Jean-François Brouckaert (Clean Sky), Christophe Hermans (CEAS Head of Aeronautics Branch), Cornelia Hillenherms (CEAS trustee), Peter Hotham (SESAR), Leonardo Lecce (AIDAA), Uwe Moeller (EREA), Olga Trivailo (DLR).
Design & Page Setting : Sophie Bougnon
sophie.bougnon1@sfr.fr

THE OFFICERS OF THE BOARD IN 2019:

President: Zdobyslaw Goraj
goraj@meil.pw.edu.pl
Vice-President, Finance:
Cornelia Hillenherms
cornelia.hillenherms@dglr.de
Vice-President, Publications and External Relations: Pierre Bescond
pierre.bescond@laposte.net
Vice-President, Awards and Membership: Kaj Lundahl
klundahl@bredband.net
Director General (including Financial Management):
Mercedes Oliver Herrero
mercedes.oliver-herrero@airbus.com
Chairman of the Aeronautics Branch: Christophe Hermans
christophe.hermans@dnw.aero
Chairman of the Space Branch:
Torben Henriksen
torben.henriksen@esa.int

FULL MEMBERS:

■ Association Aéronautique et Astronautique de France (3AF)

6,rue Galilée – F-75016 Paris
Tel.: + 33 (0) 1 56 64 12 30 – www.3af.fr
President: Michel Scheller
Secretary General: Louis Le Portz
CEAS Trustees: Michel Scheller
gestionmembres@aaaf.asso.fr
Pierre Bescond
Executive Secretary :
Anne Venables
secr.exec@aaaf.asso.fr

■ Asociación de Ingenieros Aeronáuticos de España (AIAE)

COIAE. Francisco Silvela 71,
Entreplanta - 28250 Madrid (Spain) –
Tel.: + 34 91 745 30 30
info@coiae.es - www.coiae.es
President: Mrs Estefanía Matesanz Romero
CEAS Trustees:
Mrs Mercedes Oliver Herrero
Mrs Estefanía Matesanz Romero
Secretary: info@coiae.es

■ Associazione Italiana di Aeronautica e Astronautica (AIDAA)

Casella Postale 227 – I-00187 Roma
V.R. – Tel / Fax : +39 366 144 21 31
info@aidaa.it – www.aidaa.it
President: Prof. Erasmo Carrera
Politecnico di Torino - DIMA
Corso Duca degli Abruzzi 24 - 10129
Torino, Italy
erasmo.carrera@polito.it
Secretary General:
Prof. Cesare Cardani info@aidaa.it /
cesare.cardani@polimi.it
CEAS Trustees: Prof. Leonardo Lecce
leonardo.lecce@unina.it and
Prof. Franco Bernelli Zazzera
franco.bernelli@polimi.it
Secretary: Daniela Vinazza
daniela@aidaa.it

■ Aeronautics and Astronautics Association of Romania (AAAR)

220D Iuliu Maniu Ave - 061126 Bucharest 6 – Romania, P.O. 76, P.O.B. 174 –
www.aaar.ro
President: Prof. Virgil Stanciu
vvirgilstanciu@yahoo.com
Vice-President and CEAS Trustee:
Dr Eng. Valentin Silivestru
valentin.silivestru@comoti.ro
CEAS Trustee: Prof. Ion Fuiorea
ifuiorea@yahoo.com

■ Czech Aerospace Society (CzAeS) Novotneho lavka 200/5

110 00 Prague, Czech Republic
oslcr@csvts.cz - www.csvts.cz
President and CEAS Trustee:
Assoc. Prof. Daniel Hanus,
CSc, EUR ING, AFAIAA
hanus@csvts.cz
Vice-President and CEAS Trustee:
Assoc. Prof. Jan Rohac, PhD

■ Deutsche Gesellschaft für Luft- und Raumfahrt Lilienthal-Oberth e.V. (DGLR)

Godesberger Allee 70 – D- 53175
Bonn – Tel.: + 49 228 30 80 50
info@dglr.de – www.dglr.de
President: Prof. Rolf Henke
CEAS Trustees: Dr Cornelia Hillenherms – cornelia.hillenherms@dlr.de
and Philip Nickenig -
philip.nickenig@dglr.de
Secretary General: Philip Nickenig
Executive and Team Assistant:
Susanne Frank -
susanne.frank@dglr.de
Conference Manager: Torsten Schilling – torsten.schilling@dglr.de

■ Flygtekniska Föreningen (FTF) – Swedish Society for Aeronautics and Astronautics

Kaj Lundahl -
c/o SSC Box 4207 – SE-171 04 Solna
T: +46-8-627 6200
klundahl@bredband.net
President: Captain Roland Karlsson
St - Persgatan 29 5tr, SE -
602 33 Norrköping
Tel.: + 46(0)11 345 25 16
+ 46 (0)705 38 58 06
rkrolandk@gmail.com
CEAS Trustees:
– Kaj Lundahl
– Prof. Petter Krus : Linköping University SE - 58183 Linköping – petter.krus@liu.se – +46 13 282 792 – +46 708 282 792 (mob)
Secretary: Björn Jonsson – FMV AL Flyglogistik – SE-115 88 Stockholm, Sweden – bjorn.jonsson@fmv.se

■ Nederlandse Vereniging voor Luchtvaarttechniek (NVvL)

c/o Netherlands Aerospace Centre
Anthony Fokkerweg 2
NL- 1059 CM Amsterdam
Tel.: + 31 88 511 3055 (secretariat)
nvvl@nlr.nl – www. nvvl.org
President: Christophe Hermans
CEAS Trustee: Christophe Hermans
christophe.hermans@dnw.aero
Secretary General and CEAS Trustee: Fred Abbink
f.j.abbink@planet.nl

■ Polish Society of Aeronautics and Astronautics (PSAA)

Nowowiejska 24 – 00-665 Warsaw –
Poland – Phone : +48 22 234 5428
http://psaa.meil.pw.edu.pl/
President: Tomasz Goetzendorf-Grabowski: tgrab@meil.pw.edu.pl
Treasurer: Jacek Szumbarski
jasz@meil.pw.edu.pl
Secretary General: Andrzej Zyluk
justyna.staniszewska@itwl.pl
BoD Members: Tomasz Rogalski,
Zbigniew Koruba
CEAS Trustees: Tomasz Goetzenford-Grabowski; Zdobyslaw Goraj
Administrative Officer:
Beata Wierzbinska-Prus
bprus@meil.pw.edu.pl

■ Royal Aeronautical Society (RAeS)

No.4 Hamilton Place – London
W1 J 7 BQ – United Kingdom
Tel.:+ 44 (0)20 76 70 4300
raes@aerosociety.com
www.aerosociety.com

President: Rear Adm Simon Henly CEng FRAeS
CEAS Trustee: Emma Bossom
emma.bossom@aerosociety.com
Chief Executive: Sir Brian Burridge FRAeS

■ **Schweizerische Vereinigung für Flugwissenschaften/Swiss Association of Aeronautical Sciences (SVFW)**
ETH Zurich – Institute of Fluid Dynamics – Ms Bianca Maspero
CH 8092 Zurich – www.svfw.ch
President and CEAS Trustee:
Dr Jürg Wildi: juerg.wildi@bluewin.ch
CEAS Trustee: Dr Georges Bridel
c/o ALR, Gotthardstrasse 52, CH 8002 Zurich
georges.bridel@alr-aerospace.ch

■ **Central Aerohydrodynamic Institute Russian Aerospace Society (TsAGI)**
1, Zhukovsky St. – Zhukovsky, Moskow region, 140 180, Russian Federation
Chief Scientific Officer:
Sergey L. Chernyshev, D.Sc.
ved@tsagi.ru – www.tsagi.com
CEAS Trustee: Evgeni Andreev – andreev@tsagi.ru
evg_andreev@tsagi.ru

CORPORATE MEMBERS:

■ **ESA**
8-10, rue Mario Nikis - F-75015 Paris
CEAS Representative: Torben Henriksen – www.esa.int
■ **EASA**
Konrad - Adenauer - Ufer 3
D-50542 Cologne (Germany)
Tel.: +49 (221) 8999 0000
http://easa.europa.eu
CEAS Representative:
Erick Ferrandez
■ **EUROCONTROL**
Rue de la Fusée 96 - Brussels 1130
CEAS Representative: Marc Bourgois
http://www.eurocontrol.int
■ **EUROAVIA**
Kluyverweg 1 - 2629 HS, Delft, NL
President and CEAS Representative: Juan Manuel Lora Alonso
juan.alonso@euroavia.eu
Tel.:+ 39 366 81 70 482
CEAS Representative:
Daniele Vangone
daniele.vangone@euroavia.eu – www.euroavia.eu

SOCIETIES HAVING SIGNED A MOU WITH CEAS:

■ **Académie de l'Air et de l'Espace (AAE)**
1, avenue Camille Flammarion – F-31500 Toulouse
www.academie-air-espace.com
■ **American Institute of Aeronautics and Astronautics (AIAA)**
12700 Sunrise Valley Drive
Suite 200, Reston
VA 20191 – 5807 USA
karens@aiaa.org - www.aiaa.org
■ **Chinese Society of Astronautics (CSA)**
CSA Zhang yao – WANG Yiran,
n° 8, Fucheng Road, Haidian district
P.O. Box 838
100 830 Beijing, China
Csa_zhangyao@sina.en
wanggyr@spacechina.com
www.csaspace.org.cn/
■ **European Aeronautics Science Network (EASN)**
President: Prof. Spiros Pantelakis
EASN Prof.Spiros Pantelakis
Rue du Trône 98 – 1050 Brussels, Belgium – www.easn.net
■ **Association of European Research Establishments in Aeronautics (EREA)**
Chairman: Catalin Nae – INCAS
EREA Secretary: Anne-Laure Delot – ONERA, anne-laure.delot@onera.fr
■ **International Council of the Aeronautical Sciences (ICAS)**
President: Susan Ying
Executive Secretary: Axel Probst
c/o DGLR – Godesberger Allee 70 – D- 53175 Bonn
icas@icas.org – www.icas.org
■ **Korean Society for Aeronautical and Space Sciences (KSAS)**
Room 1001, 635-4
Yeogdam-Dong
135-703 Gangnam
Gu Republic of Korea
ksas@ksass.or.kr
http://eng.ksas.or.kr
■ **Society of Flight Test Engineers (SFTE-EC)**

SIX SOCIETIES EUROPEAN AEROSPACE SCIENCE AND TECHNOLOGY RESEARCH CLOSELY LINKED WITH CEAS:

■ **EASN: European Aeronautics Science Network**
Chairman: Prof. Spiros Pantelakis (University of Patras)
spiros.pantelakis@easn.net
Vice Chairman: Zdobyslaw Goraj (Warsaw University of Technology)
goraj@meil.pw.edu.pl

■ **ECCOMAS: European Community on Computational Methods in Applied Sciences**
Edificio C-1, Campus Norte UPC
c/Gran Capitan s/n
08034 Barcelona (Spain)
www.eccomas.org/
eccomas@cimne.upc.edu
President: Michal Kleiber
mkleiber@ippt.pan.pl

■ **ERCOFTAC: European Research Community on Flow Turbulence Air Combustion**
www.ercoftac.org/
Chairman of Executive Council:
Prof. Ananias Tomboulides
ananias@googlemail.com

■ **EUCASS: European Conference for Aero-Space Sciences**
www.eucass.eu
EUCASS President: Walter Zinner (Airbus Defence and Space)

■ **EUROMECH: European Mechanics Society**
www.euromech.org
President: Prof. Gertjan van Heijst
G.J.F.v.Heijst@tue.nl

■ **EUROTURBO: European Turbomachinery Society**
www.euroturbo.eu/
Chairman: Prof. Francesco Martelli
francesco.martelli@unifi.it

EDITORIAL

Jean-Pierre Sanfourche
Editor-in-Chief

ABOUT FALCON HEAVY TRIUMPHANT LAUNCH, 11 APRIL 2019

SpaceX's Falcon Heavy launcher has performed its second flight on Thursday 11 April 2019 carrying out the Arabsat-6A communications satellite. It lifted off from the Kennedy Space Center (KSC) at 18:35 UTC, taking about 34 minutes to deploy the payload into geosynchronous transfer orbit. Falcon Heavy is a two-stage vehicle with two liquid-fuelled boosters strapped either side of the first stage to provide additional thrust. Capable of delivering 63,800 kg payload to Low Earth Orbit or 26,700 kg to Geosynchronous Transfer Orbit, it is the most powerful rocket currently flying worldwide.
SpaceX has designed falcon Heavy for reusability, seeing recovery and re-use of components as a way to reduce the cost of access to space, with expensive hardware.
Two and a half minutes after liftoff, the two side boosters shut down, detaching from the centre core and reorienting themselves for their recovery manoeuvres. Seventeen seconds after separating the two side boosters performed near-simultaneous boost back burns, each firing three engines to change course and head back towards their launch site at KSC.
Because recovery of the centre core was attempted at sea, it did not make a boost back burn. The centre booster made its perfect landing aboard a drone ship a ways off shore.

SpaceX is going to repair and refurbish the two side boosters with the intention to make fown them again in about two months. In case of success, it will be quite a decisive demonstration that reusability concept is the way to bring down the cost of access to space.

Ariane next
Facing such remarkable performances, Europe has to intensify and accelerate the works for preparing the future of Ariane 6.
Precisely Arianegroup and CNES have recently signed a Memorandum of Understanding to create *Arianeworks*, an acceleration platform particularly dedicated to boosting innovation for future space transportation systems, taking reusability as a priority holder technical objective, with commitments to make reducing costs priority number one. This partnership where teams together work in a flexible environment, open to new players, is placed in ideal conditions to promote major innovations.
All necessary means must be provided to this unit in order to optimise its chances of success to allow Europe maintain its high ranking international position in space transportation.
The works of *ArianeWorks* will be presented at the next ESA Council Meeting at Ministerial Level called 'Space19' which will take place on 27-28 November in Seville, Spain. They will notably include a clear roadmap for Ariane Next and a number of first developments to be conducted, hopefully marking a decisive step forward.

CONTENTS

PRESIDENT'S MESSAGE

Zdobyslaw Goraj
CEAS President

THE CEAS TRUSTEES BOARD MEETING HELD IN WARSAW ON 19 MARCH

The CEAS Board of Trustees meets two times a year to discuss the most important issues related to our activities. In Warsaw, the items on the agenda were: CEAS Membership, Member Societies' activities, CEAS Strategy and Objectives, Branding, Branches & Technical Committees, Publications (CEAS Space Journal, CEAS Aeronautical Journal and AEROSPACE EUROPE Bulletin), secretariat support, Permanent Programme Committees and Technical Committees, Awards and International Cooperation. An essential part of the discussion was focused on the AEC2020 Conference (Bordeaux, France, 25-28 February 2020), on the HISST Conference (Bruges, Belgium, 19-23 April 2020) and on the AEC2021 Conference (the call for proposals will be released in the months to come). During a short lunch break, participants of the BoT meeting visited selected laboratories.

In the Laboratory of UAV integration

In the Laboratory of composite structure manufacturing (CFRP shells impregnated with resin system in the vacuum infusion process)

CEAS TAKES RESPONSIBILITIES FOR HISST CONFERENCES

During the period after Warsaw BoT meeting, an extensive discussion between CEAS and HISST conference representatives took place. It was focused on the role of CEAS in organising the HISST Conference and taking the responsibility (partly organisational and fully financial) for it. The first edition of the 'International Conference on High-Speed Vehicle Science and Technology' (HISST) was held on 26-29 November 2018 in Moscow, on the occasion of TsAGi's 100th anniversary. In the voting procedure performed in April 2019, the CEAS BoT decided to sign a contract (zero vote against!) with the Belgian company ATPI, specialized in organisation of events, including scientific conferences. Engagement of ATPI will guarantee that the next HISST conference to be held in Bruges from 19 to 23 April 2020 will be prepared at the highest professional level. We expect that it will attract more than 300 participants from the whole world. Besides it is worthy to mention that we have got the support from two of our Corporate Members.

HISST Conference in Moscow 2018 – Prof. Kirill Sypalo – TsAGI CEO welcomes to the conference

Opening ceremony in Moscow 2018 – from the left: Adam Siebenhaar (HISST International Technical Committee) and Christophe Hermans (CEAS President)

TOWARDS AEC2020: BORDEAUX (FRANCE), 25-28 FEBRUARY 2020

To pave the way for a single European Aerospace Conference, CEAS and 3AF decided to join their forces to organise its first edition: **AEC2020**.
Abstract submission platform was opened at the beginning of April (see pp. 26-30) and will be closed on May 31st. To assess the advancement of AEC2020 and overcome some possible obstacles, CEAS and 3AF have decided to organise a management meeting on 18 June, at Le Bourget Air Show. It will bring together CEAS Officers, Past Presidents and Presidents of DGLR and RAeS, 3AF President Michel Scheller, and members of the AEC2020 Steering Committee.

INTERVIEW WITH PASCAL LEGAI, DIRECTOR OF THE EU SATELLITE CENTRE

WORKING FOR EU'S COMMON FOREIGN AND SECURITY POLICY

By Jean-Pierre Sanfourche, Editor-in-Chief

SatCen Director Pascal Legai ©SatCen

***Brigadier General Pascal LEGAI,** has been an intelligence officer in the French Air Force since 1988. He acquired experience mainly in the fields of geography, imagery, international relations, Space and Security issues. He had been appointed as a geographer in the French Air Force staff in Paris for 5 years (1994-1999). He was also the Head of the French Imagery Intelligence Centre (2004-2006), Human Resources adviser of the French Air Force (2006-2008) and the Commanding Officer of the French Air Force Base in Grenoble (2008-2010). He has extensive international experience in geospatial and intelligence domains.*

He has a PhD in International Relations, a law degree, several master degrees in Imagery Processing, Computer Sciences, in History, in British Civilization, in Mathematics and an Engineer Diploma in the field of the geographic sciences.

After four years as Deputy Director, Pascal LEGAI has been elected by the Member States as the EU satellite centre Director since the 1st January 2015, an imagery analysis centre, based near Madrid, Spain, providing Geospatial Intelligence (GEOINT) and Imagery Intelligence (IMINT) products and services to support the EU external action.

GENERAL BACKGROUND:

- **Are the different texts defining the mission of the EU SatCen presently evolving or not?**
- **How are the relations with the EU High-level authorities?**
- **Who are your users and partners?**

Answer - The mission of the European Union Satellite Centre – EU SatCen – is to support the decision making and actions of the European Union (EU) in the field of the Common Foreign and Security Policy (CFSP), in particular the Common Security and Defence Policy (CSDP). We depend on the Council of the EU and the details of our mission are expressed in the Council Decision dated 26 June 2014 establishing an EU Satellite Centre, the SatCen governance document. The High Representative of the Union for Foreign Affairs and Security Policy, has the possibility to suggest amendments of this document to the Member States after a period of five-year implementation.

The EU SatCen is a civilian agency, and not a military organisation. It serves the EU and its citizens, covering dual needs.

Our two main authorities are:

- The Political and Security Committee (PSC), which is composed of the 28 Ambassadors representing the Member State, and exercising the political supervision over the SatCen.
- The HR, the High Representative for Foreign Affairs and Security Policy, Ms Federica Mogherini, having the operational direction of the SatCen;

Regarding the users of the Centre:

- The HR and the European External Action Service (EEAS) are our main customers. The EU SatCen is fundamentally an Intelligence Centre executing tasks to support the EU external action in the CFSP/CSDP field.
- Moreover, the EU Member States, the EU missions (civilian) and EU operations (military), the European Commission (EC), other EU agencies such as Frontex, the Third States and international organisations for instance the UN (United Nations),the OSCE (Organisation for Security and Cooperation in Europe) and OPCW (Organisation for the Prohibition of Chemical Weapons).

Talking about our services and products, they meet diverse needs:

- Talking about our services, the EU SatCen supports: humanitarian aid missions, contingency planning (for controlling sudden and unforeseen situations), general security surveillance, EU operations;
- EU SatCen analyses: critical infrastructure, military capabilities, weapons of mass destruction (arms control, non-proliferation treaty control);
- EU SatCen contributes to EU programmes and projects related to security and space, or to processing, interpretation or dissemination tools.

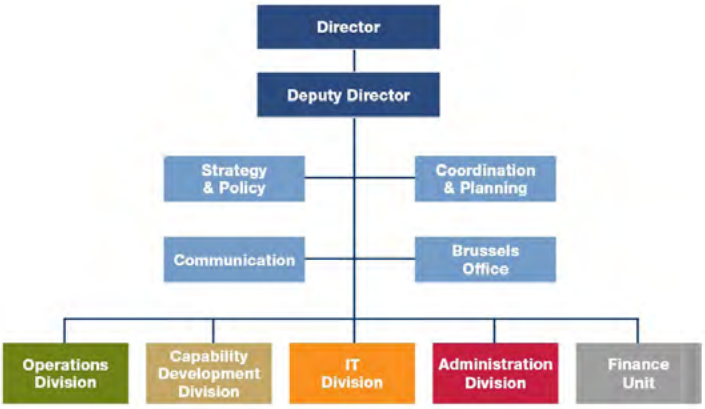
Our main partners are the EDA (European Defence Agency), the European Commission chiefly for the Copernicus programme and its security component, ESA (European Space Agency) and other institutions and international organisations, but also Industry for space data access and processing.

How are you structured and organised?

Answer – The EU SatCen was founded in 1992 as part of the WEU (Western Europe Union) and was later, on 1st January 2002, incorporated into the EU. It is located in Torrejón de Ardoz, in the vicinity of Madrid (Spain).

SatCen building, ©SatCen

We are organised as indicated in the chart below.
Our staff comprises today 140 people in total from 19 EU Member States.

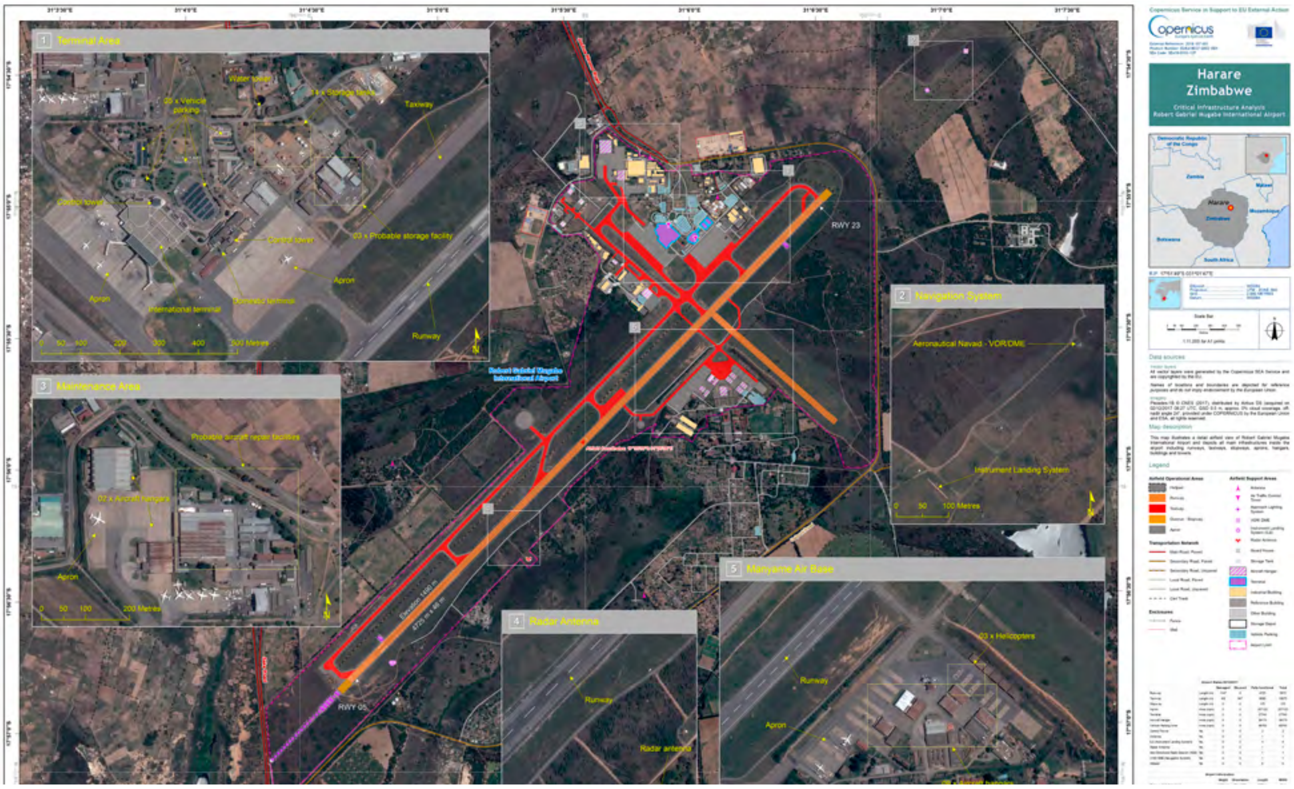


The SatCen delivers mainly GEOINT (Geospatial Intelligence) products embracing the comprehensive analysis of geospatial information to describe, assess and visually depict physical features and geographically referenced activities on Earth. GEOINT data sources include imagery and mapping data as well as collateral data, using all spatial skills and disciplines, including photogrammetry, cartography, imagery analysis, remote sensing and terrain analysis:
- **What are the different sources of the data?**
- **What are the main military applications of GEOINT?**
- **What about the civilian applications?**

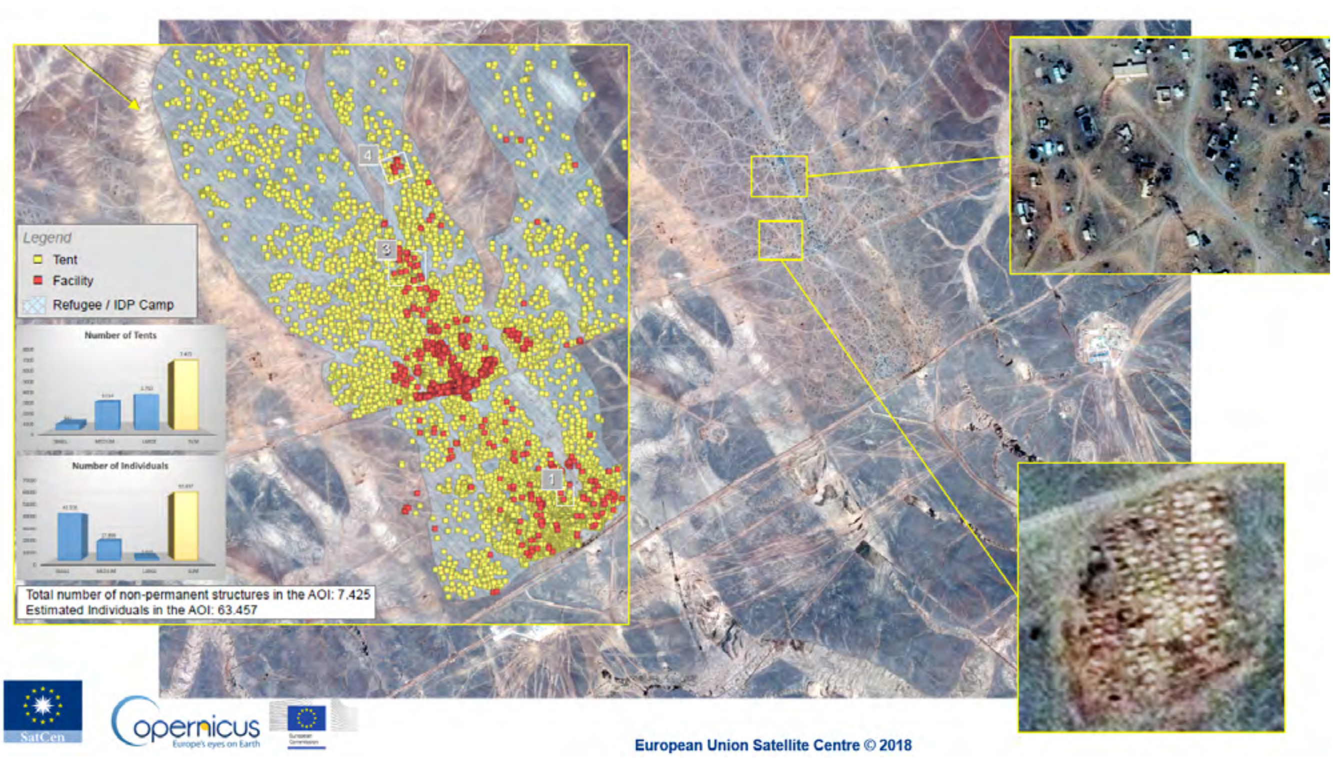
Answer:
- SatCen does not own and does not operate satellites: we are providers of imagery analysis, our added-value, and we get the images to be analysed from our different providers, which are mainly commercial, such as Airbus Defence & Space for Pleiades imagery, E-GEOS for COSMO-SkyMed imagery and Digital Globe for WorldView imagery.
- SatCen also has access to governmental systems:
  - Concerning the HELIOS II satellite, it is owned and operated by a Consortium comprising Belgium, Greece, Italy, Spain and France;
  - the radar space system SAR Lupe, owned by Germany;
  - and the Italian dual-use radar system COSMO-SkyMed.

New agreements are presently under discussion between the EU and the potential contributing nations: with Germany for SARah (radar), with France for CSO (*Composante Spatiale Optique*), with Italy for COSMO-SkyMed 2G, and with Luxembourg for the NAOS satellite (National Advanced Optical System). It is to be noted that access to governmental imaging satellites is submitted to extremely strict conditions.
The SatCen has access to the Sentinel satellites of ▶

Example of support to EU NAVFOR Somalia Operation Atalanta ©SatCen © CNES 2017, Distribution AIRBUS DS



Example of a Copernicus Support to EU External Action product – Critical Infrastructure Analysis © European Union 2018. All Rights Reserved. Copyright of original imagery remains with the provider. This product remains the property of the European Union.



Monitoring of changes in refugee camp © European Union 2018. All Rights Reserved. Copyright of original imagery remains with the provider. This product remains the property of the European Union.

Copernicus and the Commission satellite data base too. Applications are multiple: military activities and infrastructures, but civilian as well, for example natural or man-made disaster damage assessment, refugees situation, migratory flow observation, evolution of industrial infrastructures.
The concept of remote sensing applied to modern analyses stays at the core of our mission: to support decision making on a steady basis with extended support during crisis situations.

2019 CONFERENCE ON BIG DATA FROM SPACE recently took place in Munich: could you briefly summarize the most important conclusions?
Answer – This conference was co-organised by the JRC (EU's Joint Research Centre), the European Space Agency (ESA) and the EU SatCen. Hosted by the German Aerospace Centre (DLR). It was held in Munich on 19-21 February 2019. The central theme was "Turning Data into Insights": high-level experts presented advanced algorithms capable of extracting precise information from the data received from satellites. Artificial Intelligence and Machine Learning techniques were of course at the heart of all sessions. Thanks to the high number of participants – more than 500 – the discussions had a very fruitful outcome.

ARTIFICIAL INTELLIGENCE, MACHINE LEARNING: the data processing techniques are evolving faster and faster: do you have the possibility to permanently maintain the expertise of your team?
Answer – This is effectively a challenge we have to face, and among my priorities is recruiting enough high-level data scientists. Today we have five staff members with a PhD in data science. Internally, we have developed dedicated analysis tools by training models from huge amounts of accessible data.

TRAINING: courses for new staff are being organised to familiarize them with current activities and procedures:
• What is ERDAS?
• What is ArcGIS?
Answer – An important task for us is to teach our analysts, Member State analysts, but also users of geospatial products in the field of geospatial data management and processing. We organise courses on digital image processing, satellites and sensors, SatCen output standards and products and image analysis including assessment tasks. The software training is performed with ERDAS (Hexagon company) and ArcGIS (ESRI), which are also the two main software used by SatCen analysts to handle geospatial data and build products and services. We are constantly developing applied formative techniques and products such as multimedia tutorials, remote sensing imagery processing techniques, data fusion techniques, etc., in oder to constantly improve the quality of our training.
Courses are delivered by SatCen personnel, invited speakers, consultants and lecturers.

CAPABILITY INITIATIVE: SatCen conducts projects and participates in programmes aiming at developing new capabilities, what about:
• Copernicus?
• Space Surveillance and Tracking (SST)?
• Research Technology Development and Innovation (RTDI)?
Answer – EU SatCen participates in programmes and projects with the Commission or other agencies in order to improve existing capabilities and provide relevant services: Copernicus, SSA and RTDI:

- *Copernicus* comprises six families of satellites - the Sentinels: the first two are for Earth Observation (radar and optical imaging systems) whilst the four others are for atmosphere and meteorology science, land and maritime monitoring notably. SatCen uses data from Sentinel satellites in a complementary way, the accent being put on the security dimension. With 27 years of experience, we are able to make and develop products and services responding in the best possible manner to users' needs. We are supporting Frontex (border surveillance), and we support civilian external actions such as the analysis of refugee camps, damage assessment after natural or man-made disasters, and the analysis of critical infrastructure, etc.

- *The Space Surveillance and Tracking* (SST) covers three main areas: risk assessment of collision between spacecraft or between spacecraft and space debris (Collision Avoidance service); detection and characterisation of in-orbit fragmentations, break-ups or collisions (Fragmentation Analysis service); risk assessment of the uncontrolled re-entry of space objects and space debris into the Earth's atmosphere (Re-entry Analysis service). The SatCen acts as the SST Front Desk, the main interface with SST users, delivering services coming from the existing capacities of a consortium of Member States.

- *Research Technology Development and Innovation* (RTDI): its implementation aims at identifying and assessing technical and programmatic solutions concerning the whole data cycle or issues such as Big Data, Data Science and Cloud Computing, at fostering cooperation with ESA and GEO (Intergovernmental Group on Earth Observation), and also at ensuring participation in the programme Horizon 2020.

RELATIONSHIPS: how is SatCen collaborating with:
• EDA and OCCAR?
• ESA?
• Joint Research Centre of the EU (JRC)?
• French Space Agency (CNES)?
Answer – Regarding the European Defence Agency

(EDA), we are contributing to their capability development related studies: an exchange of letters between EDA and SatCen permits establishing a common roadmap. Today the GISMO GeohuB (Geospatial Information Support to Military Operations) is an excellent example of joint effective collaboration between EU SatCen and EDA.
With OCCAR (Organisation Conjointe de Coopération en Matière d'Armements), we have no direct contact.
With the European Space Agency (ESA), we are linked through an Administrative Arrangement, having access to satellite data (Copernicus in particular) and to collaborating in matter of data processing tools.

With the Joint Research Centre (JRC), we hold meetings to deal with humanitarian and security related crisis management in a complementary approach: 'Copernicus Emergency', through exercises for example.
With the French Space Agency (CNES), we keep permanent and close links, likewise with other national space agencies. A possible agreement could be set up with the CNES, which would define in detail how to share knowledge and expertise in matters of Artificial Intelligence (AI), satellite imaging systems, and data processing.

Do you collaborate with NATO?
Answer – We do not have any direct operational relations with NATO, in particular with the NATO Intelligence Fusion Centre (NIFC) located in the UK, but we are cooperating with them in the field of training with the NATO school in Oberammergau (Germany).

MUSIS: how is SatCen involved in the Multinational Space-based Imaging System?
Answer – The Multinational Space-based Imaging System (MUSIS) is a programme bringing together the next generation of military and dual-use space-based imaging systems. Its primary objective is to provide access to each nation's individual capabilities. It was integrated within the OCCAR in 2011. Presently, it enables cross utilisation by France and Italy of their respective space systems: the French Optical Space Component (CSO) and the Italian COSMO-SkyMed Second Generation.
SatCen is not part of MUSIS.

CSO: on 19 December 2018, CNES launched CSO-1, the first element of CSO, the Optical Space Component successor of Helios I and II: how is SatCen taking into account this new quite important imagery space source?
Answer – The EU is presently discussing with France in order to get access to future CSO data and to participate in programming. As long as this agreement is not reached, SatCen is not involved in the CSO operations.

What about the most important MILITARY OPERATIONS for which SatCen is working?
Answer – In this matter, we have to execute the orientations we receive from the PSC (Political and Security Committee). It is the PSC that gives us the authorisation for intervening. SatCen is for example supporting theEU NAVFOR MED operation SOPHIA.

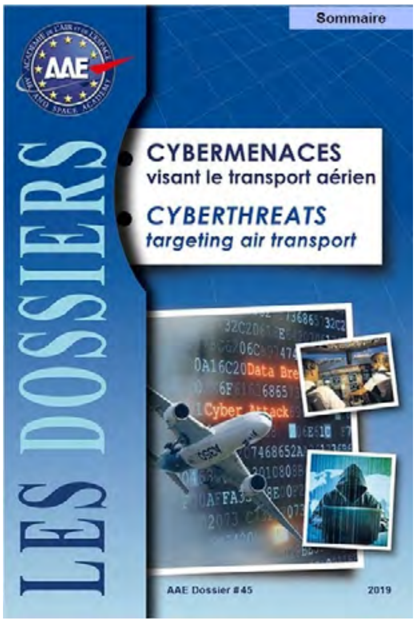
TOWARDS AUTONOMY OF EUROPE FOR DEFENCE AND SECURITY: Which role is SatCen playing in this urgent evolution?
Answer – If the EU has an easier access to the different Member States' protected space data, this evidently will concur to create the conditions for moving towards a more autonomous European external action, expression of the solidarity and cohesion between the EU and its Member States. In this area, SatCen is ideally placed to impulse the process. The SatCen performs the data analysis itself ensuring confidentiality and autonomy.

A LAST QUESTION: what are your three top priorities for 2019?
Answer – My top strategic priorities are as follows:
1. To maintain at sufficient level our human and financial resources necessary for remaining at the forefront of innovation and consequently to be able to fulfil the EU's objectives and to contribute to its level of ambition.
2. To reinforce our cooperation with the European Commission through Copernicus, security pillar enlarging the user base with new services.
3. To strengthen our support to the EU missions: military operations on one hand, civilian missions on the other hand delivering relevant support in due time anywhere on the planet.

CYBERTHREATS TARGETING AIR TRANSPORT

By Thierry Prunier

Thierry Prunier is former Director General of Uninhabited Aircraft Systems at Dassault Aviation (France). He is Member of the AAE (Académie de l'Air et de l'Espace/ Air And Space Academy).



THIS IS A SUMMARY OF "CYBERTHREATS targeting air transport", THE DOSSIER No 45 of the AIR AND SPACE ACADEMY PUBLISHED IN JANUARY 2019.
This document has been produced by a group of experts who have concentrated their works on the cyberattacks in civil air transport. Many subjects were deeply studied: a more and more connected civil transport aviation, the risks of cyberattacks and their management, the regulation and governance at the international level. Based upon these studies, a number of conclusions emerged and recommendations were formulated. In the present paper, the intention is to essentially make these recommendations known.

A SHORT INTRODUCTION

We hear more and more about cybersecurity, cyberspace, cyberattacks and cybercriminals. Faced with these new threats, air transport risks becoming less safe.
Hackers are able to break into computers, websites, networks – even the most highly protected – and cause considerable damage, including disruptions to service, blockages and even paralysis of up to several days. These attacks can also result in data or monetary theft but also, more insidiously, the insertion of a "Trojan horse" programme designed to activate on a given date or in a given context and corrupt onboard equipment software.
The air transport world forms an ecosystem or System of Systems (SoS) composed of the following elements (Figure 1):

- commercial aircraft;
- airlines;
- manufacturers and their equipment suppliers;
- air traffic management (ATM);
- airports;
- access and service providers;
- Among other services, service providers manage air-ground links and make data available;
- authorised maintenance organisations (MROs).

These players are more and more highly "connected", exchanging essentially digital data. They are also connected to the internet and to different types of "Clouds", potentially introducing loopholes for use by cyberattackers. These exchanges rely on the input of many different people: crews, air traffic controllers, airline OCC staff and airport personnel, datalink suppliers, MRO services...

In its latest annual safety report (IATA Safety Report 2016), the International Air Transport Association (IATA) proposes to clarify concepts of cybersecurity for civil aviation by distinguishing:

- "Aviation Cyber", which concentrates on potential damage to the aircraft when **on the ground**, before or after the flight, or during a maintenance phase;
- "Cyber Threat and Risk", which is focused on **Safety of Flight (**Security deals with malicious acts whereas safety deals with accidental events) aspects during flight phases, from take-off to landing (in fact from engine start-up to stop).

This dossier focuses on the above cyber threats and risks to the aircraft themselves, excluding potential cyberattacks on:

- passengers (data theft);
- airlines (disruption of online ticketing, delays, data theft...);
- airports (delays, disruption of controls and displays, etc.);
- the industrial activities of manufacturers and equipment suppliers (delays in deliveries, data theft, etc.).

The Working Group of the Air and Space Academy focused its reflections on the following subject:

> Cyberattacks can cause accidents or create serious incidents that will endanger passengers and crews.
> How to reduce the risks of occurrence and avert their consequences?

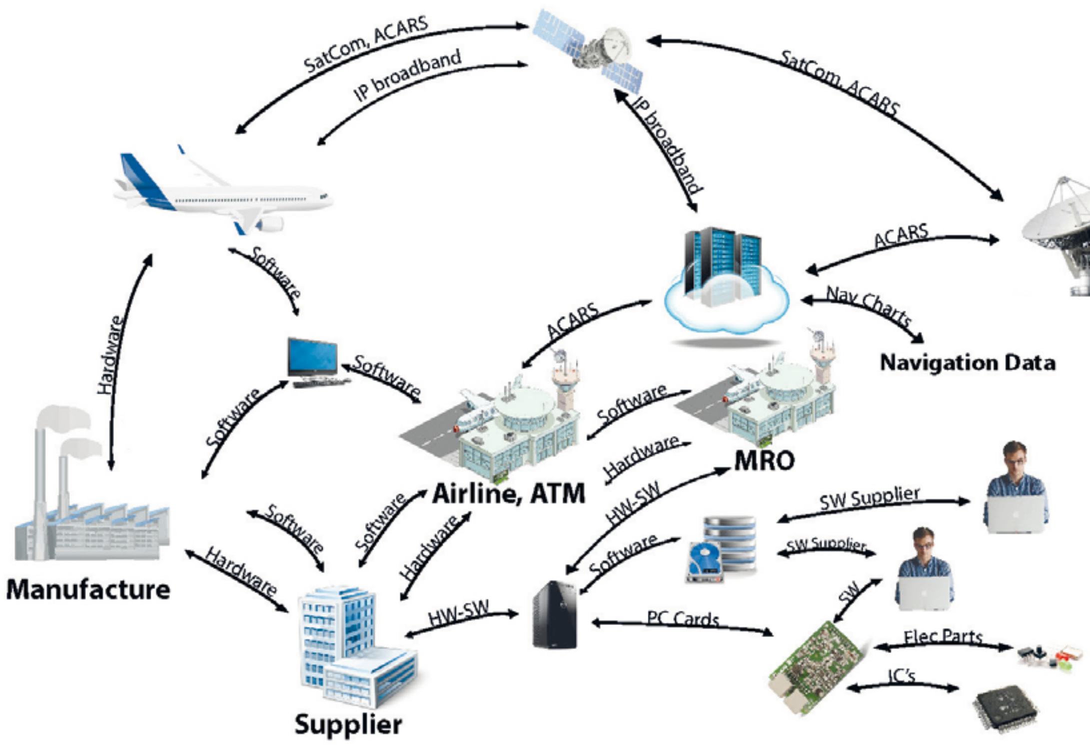


Figure 1: The air transport environment.

Cybersecurity in commercial civil aviation needs to be addressed with a Systems of Systems approach by mapping end-to-end data flows. The analysis shows that there may be loopholes in the air transport ecosystem. Vigilance should be exerted as regards the following aspects:

- **voice communications and data links** between air and ground (uplinks and downlinks);
- any cabin equipment (seat, screen, etc.) involved in **In-Flight Entertainment** (IFE) for passengers, either by direct interface or by wireless link;
- all **individual equipment** (smartphones, tablets, PCs) belonging to passengers or to flight and cabin crews;
- **data links on the ground**, when taxiing or docked at gateway, by GSM, WiFi, Wimax;
- the **maintenance chain**, since some equipment is periodically updated by download or by direct human intervention on the equipment.

The recommendations of this dossier highlight the need to define and apply norms and standards worldwide to protect onboard and ground systems – starting with the most critical ones – to exchange information on incidents and to raise awareness and promote good practices in the relevant players through training exercises.

THE AIR AND SPACE ACADEMY RECOMMENDATIONS

Civil aviation is increasingly connected thanks to modern communications means (internet, etc.) that allow high flow rates for passengers and crews. Ground systems connectivity is also improving with the development of new air traffic management systems (notably SESAR[1] in Europe and NextGen[2] in the USA).

The openness of the systems in question significantly increases the attack surfaces of air transport. Consequently, in this digital transformation, **safety and security models** must rapidly evolve to demonstrate that **cybersecurity**[3] has been taken into consideration. The plane and its crew can no longer be "isolated" during the flight but must be capable of being autonomous, while being both connected and cyber-resilient.

RISKS

Attacks against air transport can take the form of "denial-of-service" or **jamming** to block the incoming communication signals. Other possible attacks on communication links include spoofing (i.e. the transmission of **false data**), on the ground or on board aircraft. Depending on the corruption of such data, the consequences can be serious if there is no means of verifying the **availability,**

1. The SESAR (Single European Sky Air Traffic Management Research) programme is designed to update current systems to provide Europe with efficient air traffic management systems.

2. Next Generation Air Transportation System is the new US ATM system currently under development. Designed to replace the National Airspace System, it is due to be deployed in the country between 2012 and 2025.

3. The term "cybersecurity" includes the notions both of security against cyberattacks and their impact on the safety of people and goods.

authenticity, integrity, confidentiality and **traceability** of the information provided. Attacks may also target **operational software**, on board or on the ground. The presence of **malicious codes** (malware), programmed to trigger harmful actions at a specific time, is obviously a significant threat. Such malware may have been integrated at manufacturing stage of the aircraft by an agent of the manufacturer, an equipment manufacturer or a subcontractor, or may also have been inserted during maintenance operations or regular data updates.

RISK MANAGEMENT

As with risks involving hostile humans, it is necessary not only to provide fixed or adaptable protections, but also to set up organisational and human processes to fight against the attack with tools suited to the threat.
Cyberattackers are able to find flaws in practically all fixed defences of systems, including firewalls and other protections. The only real protection would be physical, with no wired or wireless communication and no possibility to transmit data by USB stick or other, but this type of protection is no longer practicable in a digitised, connected world. However, some relatively simple measures can slow down most attackers.

The high level coordination entity must ensure that all players comply with a predefined **security policy** (as recommended in ISO 270001 Standard[4]). When effective defence procedures are used, the different players' responsibilities must be clear at all times. In particular, in the case of defence actions, it is important to distinguish:

- improving **knowledge** of attack entry paths, by mapping and characterising these attacks via their signatures;
- **surveillance**, in order to rapidly detect and identify attackers and attacks, as well as their consequences, and thus guide actions;
- the **updating** of systems which have been attacked by means of software patches, in order to increase their resilience;
- the **defensive actions** themselves, including eradication of the attacks and their consequences, the possibility of tricking the attacker to orient them towards less dangerous actions and even, in some cases, return attacks.

These defensive actions have repercussions on systems organisation and management and require the engagement of reliable human resources, competent in the latest technologies, including inventive professional hackers, who can work optimally with their cyberally colleagues from other organisations.

RECOMMENDATIONS

VIS-À-VIS THE INDUSTRIALISTS

Engineering, production, operations and maintenance activities must be screened to identify, address and prevent potential vulnerabilities.

> Recommendation R1
Processes and techniques to protect manufacturers', suppliers' and subcontractors' industrial resources against cyberattacks shall be set up and monitored in order to achieve the same level of security as the Information System of the prime contractor.
Action: Manufacturers, equipment suppliers and subcontractors.

> Recommendation R2
All operators (including their freight forwarders) involved in the maintenance of onboard and ground equipment shall be certified, trained in cybersecurity procedures and regularly audited[5].
Action: Manufacturers, equipment suppliers and subcontractors.

> Recommendation R3
A policy for updating operational software and data shall be defined and implemented by all actors, with **authorised personnel, dedicated and safe means** and **secure procedures**. In particular, this includes regular implementation of software protection patches.
Action: Airlines, manufacturers, equipment manufacturers, maintenance companies and service providers.

AT DESIGN STAGE

Although cabins are still vulnerable to possible breaches of security, aircraft **cockpits** are well protected, especially on most recent aircraft, thanks to successive barriers and anti-intrusion filters. **Multimedia entertainment systems**, though, are much more open to cyberattacks.

> Recommendation R4
Onboard **multimedia entertainment** systems for passengers shall comply with cybersecurity rules to protect system operation and passengers' data; it must be,possible to **shut them down quickly**. Because of their rate of evolution, their security condition readiness shall be regularly controlled.
Action: Airlines, IFE[6] suppliers and maintenance companies.

4. www.iso.org/isoiec-27001-information-security.html
5. At least as often as stipulated in the ISO 9001 and 27001 standards.
6. IFE: In-Flight Entertainment.
7. This separation can be achieved either by using distinct communication terminals, or a single terminal, separating links by frequency, or again by multiplexing links on the same frequency but separating them logically (use of a virtual private network , VPN, for critical links).

TABLETS AND ELECTRONIC FLIGHT BAGS

> Recommendation R5
Software, data and internet connection of Electronic Flight Bags (EFB) and other electronic cockpit tablets shall imperatively be secured. Safety demonstrations – including technical checks by specialised cybersecurity empowered personnel – are mandatory.
Action: FAA, EASA and national authorities.

COMMUNICATIONS

Digital technology is everywhere: in voice and datalink communications, in navigation, surveillance and anticollision systems.

> Recommendation R6
Ground communications between air and ground shall be **segregated between different users (pilots, cabin crew and passengers)**. A risk reduction analysis based on the technical impacts and costs of the various solutions[7] is to be carried out.
Action: Manufacturers and airlines.

RADIONAVIGATION AND POSITIONING DATA

> Recommendation R7
To counter the non-availability or non-integrity of GNSS13 satellite location information due to cyber-related events, **SBAS**[8] and **GBAS**[9] systems shall evolve and **redundancy of ground-based radio-navigation means shall be maintained** in order to keep degraded mode air traffic flowing.
Action: EASA[10], national authorities and air navigation services.

SURVEILLANCE: ADS/B

An important potential vulnerability concerns **ADS/B**[11], a means of surveillance to identify and locate aircraft. Currently under deployment in the United States and Europe, ADS/B is a pillar of the air traffic management system renovation programmes SESAR and NextGen. ADS/B data is continuously transmitted by the transponder of the aircraft without the latter needing to be interrogated by the secondary radars on the ground.
ADS/B allows anyone to constantly monitor planes trajectories. Attackers using ADS/B protocol are potentially capable of generating information on "false aircraft" or transmitting false locations to the ground. Ground controllers and the crew then have to manage these false aircraft and remove doubts, which can lead to a degraded safety level. ICAO[12] (in a June 2017 document), and the US GAO[13] alert as to the vulnerabilities of ADS/B and recommend that States take risk reduction measures.
With ADS/B data issued by aircraft, mainstream sites (such as Flight Radar 24 and others) broadcast real-time information on the tracking of commercial flights.

> Recommendation R8
Before switching to the use of ADS/B as the primary means of surveillance, a **risk analysis** shall be carried out, which may lead to the setting up of additional monitoring means. The ADS/B standard should evolve to improve its level of cyber-security protection (i.e. with data authentication and/or encryption[14]).
Action: ICAO, FAA[15] and EASA.

PROTECTIONS, HUMAN FACTORS, SUPERVISION AND CONTROL

There can be no total protection; there will always be flaws in connected aeronautical infrastructures: the question is not whether there will be attacks, but rather when they will be. Air transport must therefore be more **cyber-resilient**, to ensure that aircraft remain safe and reliable, regardless of the type of attack. To this end, it is essential that **systems** and **personnel** develop **control** capabilities, recognise precisely what to do when an incident occurs, and of course, react immediately. It is also vital to detect "weak signals" that may precede cyber-incidents, denial-ofservice or other attacks.

> Recommendation R9
Personnel at risk of **cyberattacks** on air transport shall be **trained** in the methods and practices for detecting, countering or limiting a possible cyberattack.
Action: All actors.

---

8. GNSS: Global Navigation Satellite System, which includes the satellite constellations GPS, Galileo, GLONASS, BeiDou.
9. SBAS: Satellite Based Augmentation System. GBAS: Ground Based Augmentation System..
10. EASA: European Aviation Safety Agency – www.easa.europa.eu.
11. ADS/B: Automatic Dependant Surveillance – Broadcast. The aircraft periodically sends its position and other information to ground stations and other aircraft in the zone equipped with ADS-B. It emits on the 1090 MHz frequency
12. ICAO, International Civil Aviation Organization: www.icao.int.
13. Government Accountability Office report, January 2018: www.gao.gov/assets/690/689478.pdf
14. Authentication and encryption means are widely used, for instance in banking and the judiciary system.
15. FAA, Federal Aviation Administration: www.faa.gov
16. "Selected" or" manual" mode according to Airbus terminology, the other manufacturers provide equivalent modes with slightly different terminology.

Feared events are not necessarily plane crashes, but potential disorganisation or panic, whether on board, in control centres or in terminals. These events can have significant media, economic and social repercussions, leading to loss of confidence in air transport. There can also be theft of commercial information, data or files, or disorganisation of the "Supply Chain" with manufacturing blockages at subcontractor level. All these **feared events** shall be **analysed** in order to assess on the one hand the probabilities of occurrence, depending on the criteria of **ease, attractiveness and impunity**, and on the other hand the potential gravity of the consequences.

With regard to **flight safety**, the basic principle is that the crew shall ensure data consistency relating to the trajectory and energy status of the aircraft in the short term (heading, vertical and horizontal speeds, altitude, thrust) and medium term (programmed waypoints, altitude constraints, approach and programmed track, etc.). The aircraft must also be "transparent" and the crew should on the one hand have easy access to all information in autopilot mode and, on the other, have at their disposal tools and procedures to rapidly validate this data before its activation: one must not believe any uploaded data to be true without verifying it.

In case of doubt, the proposed data must be refused and other modes used as needed[16]

WHAT SOLUTIONS?

Technical solutions exist, but **failings** are also often of human origin. It is therefore important to create devices with improved resistance to unsafe **human** intervention, with "deep defences" or successive barriers to be crossed before reaching the data. In addition, long-term actions should be carried out to raise the **awareness** of the personnel, not limited to crisis periods, and not overlooking aspects such as **organisation, empowerment and training** of personnel. Each actor in the air transport industry (large airline or small service provider) shall exercise monitoring, supervision and control through regular audits. In particular, the online and offline update and maintenance operations of the aircraft are to be monitored very closely, as they are an easy gateway to human interventions that can corrupt both the hardware and the data, and introduce malware.

CRISIS MANAGEMENT

When a cyberattack is declared during operation, despite implementation and monitoring of the previous preventive measures, then action must be taken by the concerned entities, on ground and on board, in a coherent manner at national,

European, or even worldwide level when necessary. The procedures and rules to be used by crews to thwart threats will only be effective if the time required to implement them is compatible with the time available to correct the corrupt situation. However, these can be complex, risky unexpected situations, during take-off or landing phases for instance. This available time parameter shall be taken into account in the definition of corrective actions.

Similarly to organisation of the civil or defence security forces of each country, each actor involved in air transport must comply with a **safety policy** precisely defining the operating modes to be used when faced with the different types of attack, whether observed or anticipated.

> **> Recommendation R10**
> Crisis management procedures shall be elaborated to deal with cyberincidents and shared with all actors.
> **Action: All air transport stakeholders.**

MANAGEMENT OF CYBERSECURITY AND LESSONS LEARNED

A cybersecurity management system should exist for all air transport stakeholders, and should include a verification that the rules of IT health are properly applied and are accompanied by measures for the prevention and treatment of incidents.

Incidents will occur. Unfortunately, the player on the receiving end of the attack tends not to divulge the information – and it is difficult, even after much digging, to find the real causes of incidents and to distinguish between failures, bugs, false manipulations or real acts of malicious intent.

As with the analyses conducted into air incidents and accidents, the human factors that cause cyberincidents should be systematically examined and exploited. These include not only the decisions and actions that have been used to detect and counter a threat in due time, but also those that have resulted in a "successful" attack.

> **> Key Recommendation R11**
> All certified air transport actors shall **mandatorily report, share and then systematically process cyberincidents** in the same way as air accidents and incidents are reported, shared and analysed in a process that has led to a significant increase in air transport safety.
> **Action: ICAO, FAA, EASA and national authorities.**

Public actors have assumed their responsibilities. The US Department of Homeland Security holds briefings for cybersecurity professionals to share information about potential threats, new tools used by perpetrators and how they work.

The French Agency for Security Information Systems (ANSSI) and the European Centre for Cybersecurity in Aviation (ECCSA, created in 2017 under an EASA initiative) are aware of the threats related to air transport and

analyse, characterise and share them (in a secure way) with the concerned actors. These agencies have yet to reach full capacity.
Industrialists in the United States have set up Information Sharing and Analysis Centers (ISACs). The same kind of centres are in the process of being created in Europe.

STANDARDS, CERTIFICATION AND REGULATORY ASPECTS

With regard to **regulation and certification**, some standards exist but remain to be applied, and their implementation must then be regularly monitored by audits conducted by certified authorities or laboratories. There is, however, no coordination and harmonisation of regulations at worldwide level.

> Key Recommendation R12
There is an **urgent** need to develop a **harmonised worldwide regulatory framework** for cybersecurity in civil aviation, within a global management system (integrating security and safety) and to ensure its implementation and compliance **through qualified cybersecurity entities.**
Action: ICAO Member States and regulatory bodies.

The example of the security standards of the payment card industry is an interesting one. Set up in the 2000s, a standard was created to increase control over cardholder information in order to reduce the fraudulent use of various payment instruments.
Banking authorities – while retaining their role of certification – delegated responsibility for the technical evaluation to qualified trusted third parties to enable an efficient industrial response internationally.
The certification of interbank exchanges for credit cards, as well as procedures for updating internet "boxes", should serve as examples in order to develop a system of **cybercertification** in the area of air transport and to ensure the security condition readiness.

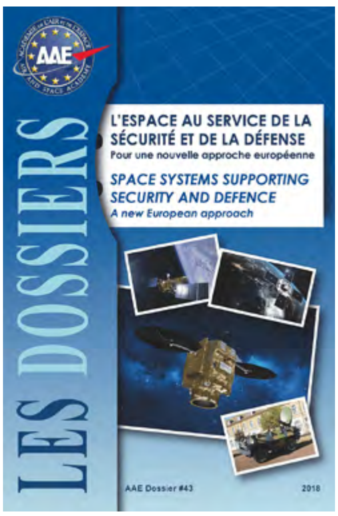
> Recommendation R13
Certification and authentication processes for sensitive data exchanges based on industry standards shall be developed or adapted and implemented.
Action: Industry.

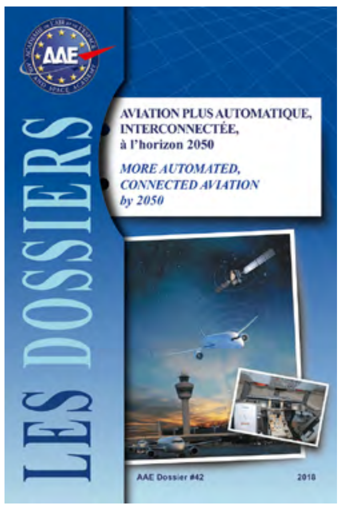
GOVERNANCE

The real difficulties concern **governance and responsibility**, complex problems linked to different legal regimes, to public and private actors and to different links in the supply chain. The chain of **cybertrust** in civil aviation needs to be strengthened. **International organisations** such as ICAO, IATA, CANSO, EASA, etc. are aware of cyber threats and risks to air transport. As emanations of States and of the involved actors, instead of limiting themselves to understanding, acknowledging, recognising, encouraging, promoting, supporting, welcoming... they should obtain **mandates from them to act quickly.**

> Key Recommendation R14
ICAO shall lead and coordinate at worldwide level all activities contributing to enhancing cybersecurity in civil aviation. EASA and national authorities shall be **given a mandate** to **define and decide on cyber action plans** and quickly put in place **roadmaps** with associated **resources and timelines** together with minimum short term measures.

Of course, the above recommendations can only be adopted and implemented by means of close coordination, harmonisation and collaboration between all air transport stakeholders.





PROPOSAL: A METHOD FOR LIMITING THE CLIMATIC HEATING AND FOR TRIGGERING OF RAINFALL

By Serge Larigaldie, former Research Master at ONERA (French Aerospace Lab), and Ph.D Theses Director at Sciences University of Orsay (France)

TO WHOM IT MAY CONCERN…

1. Introduction

Following an early publication by E. Barretto and I. J. Mulcahy (1965), a series of experiments carried out at ONERA has confirmed the effectiveness of gaseous ions in the nucleation processes of water molecules (S. Larigaldie and J. Cariou 1978). The production of micro ice cubes capable of generating condensed water vapor - or even raindrops - was shown to take place in extremely short times, of the order of a few microseconds.

Otherwise, H. Svensmark (1998, 2007) has highlighted the fact that longtime variations of the Earth climate are correlated to the magnetic activity of the sun. Namely: an increase in the magnetic field generated by solar activity would lead to a decrease in the number of very high energy cosmic particles that enter the solar system from outer space. Consequently, the decay of the flow of highly ionizing electrons that bombard the Earth's atmosphere would in turn decreases the production of ions O_2- and N_2+ in the ambient air ; hence the density of the sites of nucleation of water vapor, and in ended the global rainfall on the planet.

After a brief recall of the properties and applications of supersonic injection using wet air condensation, this article aims to the possibility of limiting global warming by seeding the Earth's atmosphere with charged particles ; these being ejected in ambiant air from supersonic injectors installed on numerous aircrafts and/or on dedicated drones.

Electro-Gaz-Dynamic injectors with humid air condensation

At the beginning of 1975, ONERA began the study of electro-gaz-dynamic (E.G.D.) injectors with humid air condensation. The objective was then to stabilize by means of a servo-loop the electric potential of aircrafts; and more specifically of helicopters (S. Larigaldie and N. J. Félici 1980, N. J. Félici et S. Larigaldie 1980). This requires to evacuate into the atmosphere an electrical current of several hundred micro-amperes from an aircraft that charges by triboelectricity during flight by friction on airborne particles.

To eject electric current into the atmosphere, a metallic sharp needle was located at the throat of a small supersonic nozzle and raised to a D.C. voltage of a few thousands volts **(Fig. 1).** The tip of the needle was located at the throat of the nozzle precisely. At this position air flow

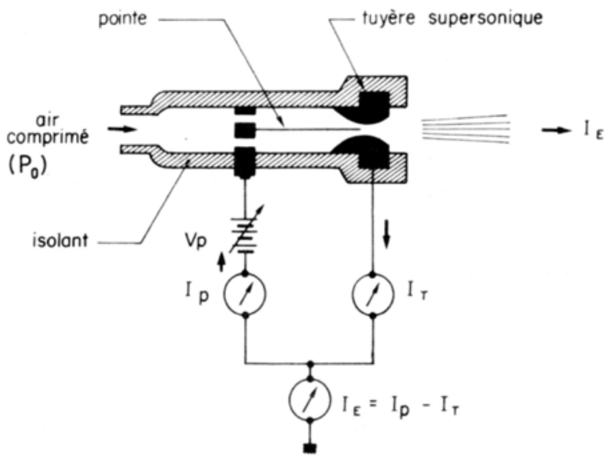


Figure 1 : Schematic of a D.C. current supersonic E.G.D. injector

has became widely oversaturated, and the gaseous ions emitted the corona discharge then constitute very efficient condensation nuclei for the water vapor present in the compressed air. Almost immediately, charge carriers take the form of micro ice-cubes consisting of one individual ion coated with about ten thousands water molecules. Because of their low mobility those particles are then driven out of the nozzle by the aerodynamic flow, despite the electric field which tends to bring them back to the metallic walls of the nozzle.

In an additional application, the flow of micro ice carriers air was directed towards part of the fuselage of a plane at ground. Without radiating electromagnetic disturbances by itself, the supersonic injector made it possible to accumulate significant electrical charges on a well-defined isolating surface of the aircraft. This replicates the triboelectricity charging processes of a plane moving in precipitation, and induces sparks similar to those that may disturb the aircraft in flight. Since these sparks came from the precise location where the charged air jet was directed, the correlation with the disturbance of the radionavigation devices made it possible to locate the sources of interference and to determine the means of remedying them.

The process was validated during two campaigns at Avion Marcel Dassault in Istres, (S. Larigaldie and J. Reibaud 1980) first on "Falcon 10" (see for instance surface discharges on **Fig. 2**) and then on "Alfa-jet" (**Fig. 3**) . It was also the subject of a permanent demonstration at the Salon du Bourget in 1980. Commercialized by the companies Ecopol and Shelton, this device has been acquired and used by many aeronautical manufacturers inclu-

Figure 2 : Gliding sparks on a plane's fuselage bombarded by an E.G.D. ion gun

Figure 3 : Early investigations of radio-electric disturbances on an A.M.D. Alpha-jet

ding A.M.D. , SAAB, Boeing, Aerospace, etc.
Finally, the supply of the corona discharge by a high alternating voltage (50 Hz) makes it possible to successively inject electric charges of both polarities into the ambient air. This causes, by increasing the conductivity of the medium, a drastic elimination of unipolar electric charges carried by insulators or isolated conductors, this in a radius of several meters around the neutralizer (S. Larigaldie and N. Giboni 1981). The difficulty then lies in the balancing of the currents emitted during the positive and negative alternations of the high voltage. As show on **Fig.4**., the solution was to isolate the discharge tip by a capacitor and to drown a grounded metal ring inside an insulating nozzle. This arrangement automatically polarizes the discharge tip to a continuous value which counterbalances the dissymmetry of the corona effect. (P. Poidras 1987). It has been shown that this technique can be used for avoiding spark generation and particle contamination, as well as for dissociating flocks in fluidized bed dryers. (J. Taillet 1993, 1997, 2003).

In summary, several important points emerge from the observation of corona discharges switched in a supersonic flow inside a metal nozzle:

- As soon as the supersonic nozzle is initiated, the corona discharge at the throat appears completely stabilized: the periodic pulses: "pulses de Trichel" in negative polarity or "streamers" in positive polarity, give way to a continuous emission of electric current.
- No spark then occurs between the high voltage tip and the inner wall of the metal nozzle.
- As a result, unlike corona discharges into the ambient air, supersonic E.G.D. injectors do not emit radio-frequency radiations in operation.
- Whatever the intensity of the current that feeds the discharges, no traces of ozone were detected during the operation of the injectors.

Influence of condensation trails

According to the experts of the I.P.C.C. (2014), the share of civil aeronautics, that is about one hundred thousand aircrafts in flight at any moment around the planet, in the emission of carbon dioxide would be about 2.4% (emission to which should be added those of methane, ozone, of water vapor, of sulphate and soot aerosols, etc…). Different analysis were published subsequently, however, there is one essential element published by R. Meetkoter et al. (1999) showing that the condensation trails emitted by the aircraft should cool the ground during the day by the effect of albedo and warms it during the night by greenhouse effect while opposing the escape of thermal radiations from the soil to the space. This effect have also been demonstrated by D. J. Travis et al. (2002). Following

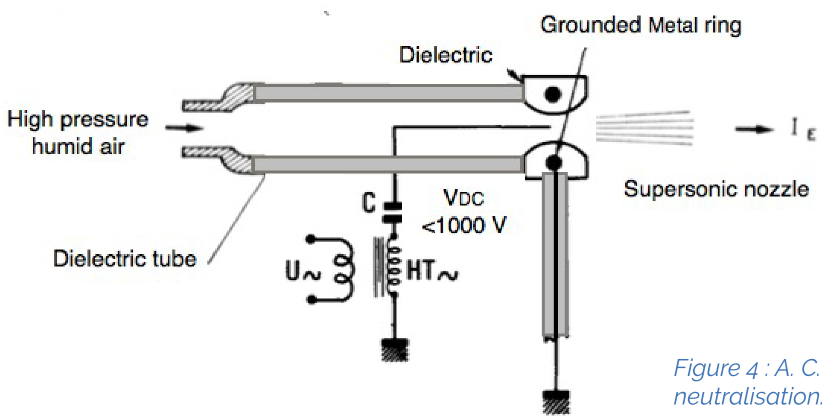


Figure 4 : A. C. configuration for E.G.D for electrostatic neutralisation.

the New York attacks of 11 September 2001, the overflight of the city of New York was then banned for three days, and a change of several degrees of the ratio of daytime and nocturnal temperatures had been recorded during this period : "*at least a portion of this anomaly was attributed to the absence of contrails during this period*".

Toward a reduction of the radiative forcing of the atmosphere

The idea is to sow the upper atmosphere in electric charges by placing supersonic injectors at the wingtips of airliners. This process should be able to considerably amplify the diurnal condensation trails, or even trigger the formation of cirrus, without polluting emissions in the upper atmosphere. Inverse polarity or A.C. injectors, arranged on each wing would be supplied in compressed air by the compressors of the reactors, and the high voltage which controls the corona discharges would be switched only during the diurnal flights, according to instructions elaborated by meteorological centers and transmitted by radio to each aircraft.

A nocturnal action can also be considered by injecting electric charges into the low clouds that retain the transfer of thermal radiations from the surface to the space. The objective then being to cause precipitations at the beginning of the night by favoring the condensation of the vapor inside these clouds. The vectors of these interventions could be small aircrafts or even relatively simple specific drones operating within the cloud.

Otherwise, such drones, equipped with supersonic E.G.D. injectors could intervene directly inside of cumulonimbus in order to trigger precipitations before the formation of the hail. They would thus act as "recoverable" hail rockets, but probably more efficiently, and avoiding ejection of silver iodide, a very long-lived molecule, recognized as toxic at high concentration.

Finally, we now know that major meteorological disturbances, hurricanes or cyclones originate above the oceans in well-defined thermal and hydrometric conditions: high temperature of seawater to a depth of several dozen meters and very high humidity of the air above this hot water area. These relatively localized configurations are perfectly detectable from space by meteorological satellites. Inasmuch, as the diurnal and nocturnal actions of these airborne E.G.D. injectors would be effective, it would be conceivable, when treating them at birth, to inhibit or at least to limit the development of these particularly destructive phenomena.

Conclusions

Using simple technologies, supersonic E.G.D. injectors of electric charges offer the advantage of emitting only agglomerates of water (in very small quantity compared to the exhaust gas of an airplane reactor). The pollution, both chemical and radio-electric generated by these devices being quite negligible, they could be arranged on a large number of airliners and thus could increase the whole number of nucleation site in the terrestrial atmosphere. This would in turn increases the overall rainfall on the planet and consequently slow down the global warming of the climate.

What's more, these injectors can be operated in due time and place as needed. They could therefore intervene in prevention during extreme weather conditions. by triggering local precipitation before the disturbances become devastating.

References

E. Barretto and I. J. Mulcahy**, Production and Neutralization of a Charged Aerosol by Corona Fields, Journal of Physical Research **70, (6) (1965)

***S. Larigaldie and J. Cariou**, Dispositif pour Produire un Jet Gazeux Porteur de Charges Electriques. Déperditeur actif , Brevet n° 78.07.067 (1978)*

***H. Svensmark,** Influence of the Cosmic Rays On Earth's Climate, Physical Review, Letters **81**, (1998)*

***H. Svensmark**, Cosmoclimatology, a New Theory Emerges, Oxford Journals Science & Mathematics Astronomy & Geophysics **(48)** (2007)*

***S. Larigaldie and N. J. Félici**, Etude Expérimentale d'un Déchargeur Electrostatique pour Hélicoptère, Revue de physique Appliquée,**15** (1980)*

***N. J. Félici et S. Larigaldie**, Experimental study of a static discharger for aircraft with special reference to helicopter, Journal of Electrostatics, **9** ,(1980)*

***S. Larigaldie and J. Reibaud,** Procédé et Moyen de Protection des Aéronefs contre les Perturbations d'Origine Electrostatique Brevet n°80.14.848 (1980)]*

***S. Larigaldie**, Procédés et dispositifs pour transférer des charges électriques de signes différents dans une zone d'espace, et application aux éliminateurs d'électricité statique, Brevet n°80.21.977 (1980)*

***S. Larigaldie et N. Giboni**, A New Device for the Neutralisation of Static Electricity, Journal of Electrostatics, **10** (1981)*

***P. Poidras**, Etude d'un Eliminateur de Charges Electrostatiques à Haute Efficacité, Thèse de Docteur-Ingénieur soutenue le 3 novembre 1987 à l'Université Paris V*

***J. Taillet**, Elimination of static charges in the processing of bulk material, Journal of Electrostatics, **30**, (1993)*

***J. Taillet**, Applications of supersonic injection of electric charges in Chemical Engineering Journal of Electrostatics, 40, (1997)*

***J. Taillet**, Static Charge Elimination on Polymer Particulates During their Industrial Production: Supersonic Injection Technology, Powder Technology, **135** (2003)*

***Intergovernmental Group of Experts on Climate Change**, Rapport n°5, Genève, Suisse, (2014)*

***N. Stuber, P. Forster, G. Rädel & K.Shine** The Importance of the Diurnal and Annual Cycle of Air Traffic for Contrail Radiative Forcing, Nature **441**, (2006)*

***R. Meerkotter, U. Schumann, D. R. Doelling, P. Minnis, T. Nakajima & Y.Tsushima** Radiative Forcing by Contrails, Ann. Geophysicae **17**, (1999)*

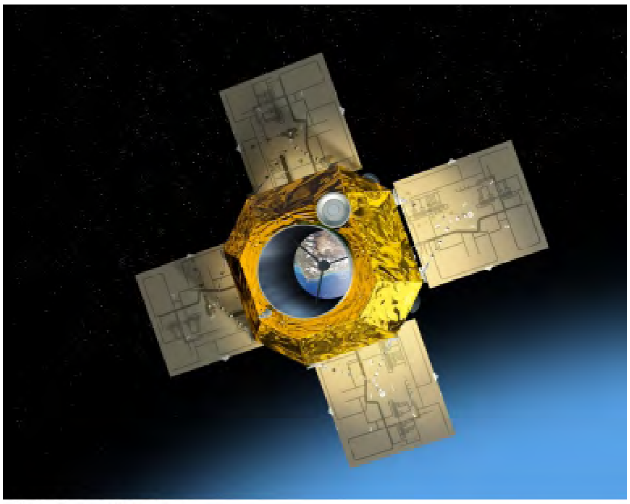
***D. J. Travis, A.M. Carleton & L.G. Lauritsen** Climatology: Contrails Reduce Daily Temperature Range, Nature, **418** (2002)*

MUSIS: THE MULTINATIONAL SPACE-BASED IMAGING SYSTEM

By Francesca Falconi, OCCAR

INTRODUCTION: MUSIS CONCEPT

The idea of a MUltinational Space-based Imaging System (MUSIS) was generated with the aim to improve and foster international cooperative Earth Observation activities through space based platforms. MUSIS comprises a federation of systems (i.e. a system of systems) that delivers space-based[1] imaging capabilities to its users, resulting in an improvement in the exploitation of systems for remote sensing, which aims to increase user satisfaction, together with a reduction in costs through the exploitation of the systems synergies.



© CNES - Septembre 2009 /Illus D. Ducros

MUSIS is based on a concept that overcomes the need to have stand-alone and non-communicating systems. MUSIS represents a bridge to enable the interoperability of spaced-based systems, that will allow users from different nations to access the resources of every system included in the federation by utilising only one workstation. In particular, MUSIS users will be able to request new images and access all the data stored in the common database of the federation.

MUSIS HISTORY, COOPERATION FRAMEWORK AND OCCAR INVOLVEMENT

MUSIS was created to provide continuity in Italian-French cooperation in the field of Earth Observation aiming to foster cooperation, exploit systems synergies and achieve cost reduction.

Based on this idea, Belgium, Germany, Greece, Spain, France and Italy initiated a cooperation agreement by signing a Technical Arrangement for a multi-national feasibility study. Its goal was to consider how each of the national systems could work within a federated system of systems. After signing a Letter of Intent, the six Nations decided in 2009 to entrust the Organization for Joint Armament Co-operation (OCCAR) with the management of the MUSIS Definition Phase. However, schedule constraints on some national systems prevented agreement on a joint approach by the six Nations. The compatibility of the Italian and French systems however, enabled these two nations to announce, in September 2010, their intention to proceed with a bilateral study, with possible future phases of the MUSIS Programme open to the participation of other Nations. On May 2011, OCCAR was entrusted with the management of the preliminary definition (Phase B) of a MUSIS federative system, which was comprised of Phases B1 and B2.

Whilst Phase B1 confirmed the feasibility of the interoperability of the Italian and French space systems and identified a possible architecture for MUSIS, Phase B2 delivered the final definition of the "Common Interoperability Layer" (CIL) connecting the French and Italian national systems.

As a result, Italy and France have authorised OCCAR to manage the integration of the MUSIS Development and Production Phases, with a potential requirement for a long-term ISS phase.

SYSTEM INVOLVED AND APPLICATIONS

The systems that will be federated by MUSIS are the French system Composante Spatiale Optique (CSO) and the Italian system Cosmo-SkyMed Second Generation (CSG).

About CSO: The CSO constellation has been developed to ensure continuity of the in-service Hélios system, with increased performance and reduced life cycle costs. From an operational point of view, CSO will provide users with improved Image usefulness (e.g. better resolution and agility, thermal activity detection etc.) and reduced response time[2]. CSO's expected service duration is longer than Hélios, despite a smaller budget in terms of investment. The CSO constellation is composed of 3 orbiting satellites equipped with an optical payload (both visible and infrared). The first satellite was launched at the end of 2018. The CSO system is managed by the French Ministry of Defence.

About CSG: The CSG dual constellation was developed to ensure continuity of the in-service COSMO-SkyMed (CSK) system. The CSG system has inherited the lessons learnt from CSK and exploits cutting edge technology for improved resolution, geolocation and agility to allow users to acquire, at the same time, a greater number of

1. *Space based systems for Earth observation and remote sensing are composed of three main segments: the satellites constellation, the Control Ground Segment devoted to control the satellites' orbits and the User Ground Segment to process data acquired by the satellites' payloads.*

images in the same area of interest. The CSG constellation, composed of 2 satellites equipped with SAR[3] sensors, will be integrated within the former CSK constellation, to achieve full interoperability through an integrated and unified ground segment. CSG is a dual system managed by the Italian Space Agency (ASI) and the Italian Ministry of Defence, and has been developed to support international cooperation.

Optical images (from CSO) and radar images (from CSG) contain complementary information and characteristics. In particular, whilst optical images can be rendered with natural colour and can easily be interpreted, radar images can be also taken at night and in all weather conditions. Radar and optical images are used currently, both for defence and security purposes, and for dual applications. These images are used for change detection (both for disaster relief and for battle damage assessment), for IMINT purposes, but also for humanitarian crisis management amongst others. In this context, it is of paramount importance that users are allowed to access several space systems at any one time, not only to maximise the probability of taking a picture for the area of interest at the desired time, but also to provide them with a complete set of data. Indeed, subsequent data elaboration generates information for decision-makers to have an increased awareness of the situation they are monitoring.

Furthermore, having an easier access to a large amount of data, results in the fostering of developments for new applications to cater for the current evolution of users' requirements. For this aspect, the MUSIS system sets the right conditions to create added value services to be used broadly, or tailored for specific applications.

MUSIS: CURRENT STATUS

OCCAR, on behalf of Italy and France, issued (in October 2018) an Invitation to Tender for the Development and Production Phases (C and D) of the MUSIS CIL to the same Industrial Consortium that undertook the Definition phase. These co-contractors, Thales Alenia Space-Italy, as lead contractor, and Airbus Defence and Space France, provided a Tender response (January 2019) that is currently under negotiation. A contract award is expected in June of this year.

MUSIS: FUTURE DEVELOPMENT

MUSIS is based on the concept that federating systems when communicating and interoperable will result in improved user satisfaction, in better systems exploitation and provide significant cost reduction, as it avoids duplicating dedicated User Ground Segments. MUSIS is a system of systems that deals with the complexity of its component sub-systems by providing a simple and ready to use Man Machine Interface for the users.

MUSIS represents a challenging programme for Industry, as it requires it to develop systems interoperability and flexibility in data exchange by respecting, at the same time, the data integrity and confidentiality required by the security standards and protocols of the two Nations.

MUSIS architecture will make available to its users a large amount of data stored in a multi-sensor common archive, fed by national systems. The availability of this large amount of data will create the conditions for developing added value services by using sensor fusion or Artificial Intelligence techniques for their exploitation.

For the future, the federation of systems could be expanded to create a multi-sensor environment, encompassing data provided by multi-spectral, lidar, C or L-band SAR sensors, creating data warehouses that could contain a large amount of complementary data.

In summary, MUSIS represents a new collaborative approach towards Earth Observation activities through space-based platforms, allowing participating Nations to build a shared operational culture that can deal with operational challenges now and in the future.

2. Response time is defined as the delay from an image being requested, to it being provided

3 SAR: Synthetic Aperture Radar consisting in a X-band SAR active antenna

CSO/MUSIS: OPTICAL MILITARY RECONNAISSANCE SATELLITES

By Jean-Pierre Sanfourche, Editor-in-Chief

The CSO satellites (CSO = *Composante Spatiale Optique*) of the MUSIS programme (MUltinational Space-based Imaging System) are reconnaissance sensors for the French military forces and their partners. Overseen by CNES (the French Space Agency) for DGA (Direction Générale de l'Armement, the French Defence Procurement Agency), they will succeed the HELIOS II system and help strengthen force capabilities in space-based intelligence and in support and execution of in-theatre operations.

The CSO constellation comprises three optical polar-orbiting satellites placed at different altitudes to fulfil a dual mission: (a) reconnaissance mission at 800 km altitude geared towards providing coverage, acquisition over theatres of operations and revisit capability; (b) an identification mission at 480 km altitude to supply imagery at the highest possible level of resolution, quality and analytical precision.

The satellites' payloads will enable day/night acquisition of very high resolution visible and infrared (IR) imagery with a range of viewing modes tailored to meet a broad spectrum of requirements. All three satellites are highly manoeuvrable and built around the same bus architecture that draws partly on the heritage of 'Pleiades'[1], affording great autonomy and agility despite a 3.5 tonnes mass. The CSO satellites will keep station thanks to their unique autonomous orbit control capability.

The CSO satellite

- *Mission: Military Earth Imaging*
- *Launch date: December 2018 CSO-1 – May 2020 CSO-2 – October 2021 CSO-3*
- *Partners: French Defence Procurement Agency (DGA)*
- *Instrument: Large telescope – visible and IR sensors*
- *Localisation: phased sun-synchronous LEO (Low Earth Orbit)*
- *Altitude: between 480 km and 800 km*
- *Mission lifetime: > 10 years*

© CNES/Mira Productions/PAROT Rémy, 2018

The overall system is designed to assure fast turnaround between tasking requests and acquisition of intelligence combined with rapid delivery of data to the point of need thanks to the mission operations timing and a ground station network with a dedicated polar station.

The French defence procurement agency DGA has delegated oversight of the satellites and mission ground segment to CNES, which is also co-system architect and in charge of satellite launch, in-orbit checkout and positioning operations.

Airbus Defence & Space France is responsible for designing and building the satellites, to be assembled at its Toulouse Facility, while Thales Alenia Spacel supplies the optical instrument.

Airbus Defence & Space France is also prime contractor to DGA. Development of the mission ground segment and the mission programming and image processing workflows involve a number of industry firms including Thales Services, Cap Gemini and CS-SI.

TIMELINE

WITH ITS THREE IDENTICAL POLAR-ORBITING SATELLITES, THE CSO CONSTELLATION IS GEARED TOWARDS DELIVERING TACTICAL AND OPERATIONAL MILITARY INTELLIGENCE, AFFORDING A LEVEL OF PERFORMANCE UNEQUALLED ANYWHERE IN EUROPE

MORE DETAIL

SHARP VISION

CSO has the ability to acquire imagery at very high and even super high resolution, thus delivering better-quality intelligence. Two satellites orbiting at 800 km are dedicated to reconnaissance, while the third – 320 km lower – captures finer detail for identification. Operating day and night, CSO's penetrating optical vision is able to identify all types of targets and their thermal signature in the infrared.

MORE IMAGERY

UNIQUE CAPACITY

Building in the heritage of Pleiades' agility, CSO is able to supply large amounts of imagery every 24 hours of orbital revolution, from the same point on the globe and in a single pass. Its ability to slew very quickly affords a range of different viewing modes, notably for multiple stereoscopic acquisitions. Compatible with the new-generation Galileo and GPS systems, CSO also offers hignly precise geolocation crucial for military targeting.

1. *Pleiades: French programme: pair of two Earth Observation satellites. Pléiade 1A was launched on 17 December 2011. Pléiade1B was launched on 2 December 2012.*

MORE RESPONSIVINESS

A SUSTAINED PACE

Ideally located near the polar circle, the Kiruna receiving station is within range of each CSO satellite for most orbits, every 100 minutes on average. Whether uplinking work plans to the satellites or retrieving imagery, this station is key to keeping up with the increasingly sustained pace of operations while maintaining currency of information. The system is able to accommodate urgent tasking requests at all times and can even adjust its revisit rates in response to geopolitical events.

FEWER CONSTRAINTS

AUTONOMOUS ORBIT CONTROL

As orbital decay causes the lowest satellite in the constellation to lose altitude, CSO has unique embedded intelligence to correct this phenomenon. The satellite processes the trajectory information from its navigation system and decides on its own what manoeuvres are required to return to its nominal orbit. Such manoeuvres remain transparent to users and are performed several times a day at times that don't interfere with tasked acquisitions, thus providing genuine operational added value.

19 DECEMBER 2018: SOYUZ SUCCESSFULLY ORBITS CSO-1 FROM GUIANA SPACE CENTRE

Wednesday 19 December 2018, Soyuz successfully accomplished from the Guiana Space Centre (CSG), Europe's spaceport in Kourou, the launch of CSO-1 (the first component of the CSO constellation), placing it into its programmed sun-synchronous orbit.

The Soyuz launcher successfully orbited the first CSO satellite from the Guiana Space Centre on 19 December 2018.
© CNES/ESA/Arianespace/CSG Service Optique, 2018

CNES Toulouse Space Centre: retransmission of CSO-1 launch, 19 December 2018.
© CNES/TRONQUART Nicolas, 2018

With a launch mass of 3,565 kg, CSO-1 is the first in a the CSO constellation which comprises three satellites.

CSO-1 was placed into a 800 km altitude-orbit from where it will acquire a very-high-resolution day/night, clear-weather imagery in the visible and IR in a range of viewing modes to serve a maximum of operational needs.

As soon as the satellite separated from the launcher, CNES teams took control to check that all systems were functioning correctly and to closely monitor the first on-board systems as they were powered up. Then they took over operations to ensure the CSO-1 satellite is operating as planned, to calibrate its instrument, to establish tasking plans and to define orbital manoeuvres.

On the occasion of this launch, CNES President Jean-Yves La Gall commented:

"This 20th straight success for Soyuz from the Guiana Sapce Centre is a great source of satisfaction. The orbiting of CSO-1 shows once again how CNES is working effectively with the Ministry of Armed Forces to develop and operate its space systems. Today, our four field centres are centre stage: Head Office liaising with the armed forces, the CST for the satellite, and the DLA and the CSG for its launch. So, I would like to congratulate all of our partners at DGA, Airbus Defence & Space, Thales Alenia and their subcontractors for the satellite, and at ESA, Arianespace and Russian manufacturers for the launch. And I would like to thank our Minister for Armed Forces, Florence Parly, who did us the honour of watching the launch from the Ecole Militaire in Paris. Thank you and well done everybody!"

Synthesis written by J.-P. S. from CNES information https://cso.cnes.fr/en/csomusis-0 and from CNES Mag #79 February 2019

EDA GOVSATCOM DEMO PROJECT ENTERS EXECUTION PHASE

Madrid - 16 January, 2019

EDA's Governmental Satellite Communications (GOVSATCOM) Pooling and Sharing demonstration project (GSC Demo) entered its execution phase this Tuesday 15 January with the first meeting of the Project Arrangement Management Group taking place in Madrid.

This means that the project is now ready to provide GOVSATCOM services to meet the GOVSATCOM demands of Member States and European CSDP actors through pooled capabilities (bandwidth/power and/or services) provided by contributing Member States. This governmental pooled capability is set up to provide satellite communication (SATCOM) resources that cannot be obtained on the commercial market with sufficient level of guaranteed access and security. The GSC Demo corresponds responds to an existing need and is fully in line with the revised 2018 Capability Development Plan and its related EU Defence Capability Priorities. It has also to be seen in the light of the ongoing efforts within the European Union to establish an EU GOVSATCOM within the EU's next space programme. Furthermore, the GSC Demo project also complements EDA's EU Satcom Market project, already in place since 2012, which provides commercially available SATCOM and CIS services in an efficient and effective manner.

Today's milestone was achieved after intensive work done since June 2017 to establish a Project Arrangement. Under the leadership of Spain, all 15 contributing EDA Member States of the project (Spain, Austria, Belgium, Germany, Estonia, Greece, France, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Sweden and the United Kingdom) accepted the Project Arrangement as baseline for mutual support and collaboration. Norway, which has signed an Administrative Arrangement with the Agency, is also contributing to the project.

EDA Chief Executive **Jorge Domecq**, who attended today's meeting in Madrid, stated: «*The role of satellite communication in a European strategic autonomy perspective cannot be overstated. I am pleased to say that EDA has played its part in facilitating SATCOM solutions for the EU for some time and in an incremental fashion that has proved quite successful. This GSC Demo project together with the Agency's EU SatCom Market project underlines the importance of SATCOM and confirms the priority that has been granted to this capability during the most recent revision of the Capability Development Plan*».

Major General **Salvador Alvarez Pascual**, the Deputy Director of Programs in the Spanish Ministry of Defence, said: «*Now it is time to start this project which is the result of significant work of experts from different nations. Spain will face the chairmanship of the Project Arrangement Management Group with confidence to have a good cooperation. The project will fulfill our common objectives and targets and provides the ideal opportunity to test its governance*».

BACKGROUND

Reliable, stable and secure communications are crucial in any CSDP mission and operation. Yet, terrestrial network infrastructures are not available everywhere, for instance in areas hit by natural disasters, at sea, in the air or in hostile zones. SATCOM can be the solution: rapidly deployable, flexible and distance insensitive, SATCOM can offer communication links where terrestrial networks are damaged, overloaded or non-existent.

However, access to SATCOM cannot be taken for granted at any time, especially not when governmental users require them at short notice and without pre-arranged agreements. In situations of high demand, competition with other users of commercial SATCOM capacities creates a risk of non-availability and high costs. Against this backdrop, EU leaders decided in 2013 that there was a need for a new solution combining the advantages of commercial and military satellite systems in order to address both civil and military needs through European cooperation. The European Defence Agency, in collaboration with the European Commission and the European Space Agency, since then is preparing the next generation of GOVSATCOM.

GOVSATCOM is seen as a capability that is placed in between the commercial satellite communication market and the highly protected military satellite communication capability.

The project originates from an EDA Steering Board decision of November 2013 which tasked EDA to pursue its work on GOVSATCOM coordination with Member States, the European Commission and the European Space Agency in order to propose a comprehensive programme for Member States who wish to participate. After a sound preparatory work, the aforementioned EDA Member States decided in June 2017 to establish the GSC Demo project and intensify their collaboration in GOVSATCOM.

AEROSPACE EUROPE CONFERENCE 2020

To pave the way for a single European aerospace conference, 3AF and CEAS have decided to join forces to launch the very first edition of the Aerospace Europe Conference (AEC2020).

Aerospace Europe Conference 2020, will feature 3AF 3rd Greener Aviation, CEAS 7th Air & Space Conference and the 8th edition of Aircraft Noise and Emissions Reduction Symposium (ANERS).

This conference will be offering scientists and engineers from industry, government, and academia an exceptional opportunity to exchange knowledge and results of current studies and to discuss directions for future research in the fields of aeronautics and space. Individually, Each of the three conferences has proven to be very successful. In joining the three we expect to be even more attractive, offering additional transversal topics and synergies between aeronautics and space towards a greener and cleaner environment

By welcoming worldwide contributions, this new conference will give attendees a unique overview of the global research efforts aimed at reducing the environmental impact of aviation and space activities.

3AF Greener Aviation

To continue serving citizens, linking people and nations worldwide, aviation must reduce its impact on the environment. This challenge is being tackled by a number of ambitious research programmes throughout the world. In the European Union, the challenge of the environment for aviation was identified by ACARE in the early 2000s and has led to unprecedented research activity in the member states and in the Union's framework, with Clean Sky as a flagship programme. Since 2008, Clean Sky and Clean Sky 2 have involved more than 1000 participants in a public private partnership between the European Union and major European aeronautical companies in order to drastically reduce local pollution, noise and global warming emissions due to aircraft, helicopters, and their operations.

The 3rd Greener Aviation conference will build on the successes of two previous editions focussed on scientific and technology solutions for aircraft and their systems, pulled by the Clean Sky programme.

The technical sessions will cover all the aircraft, engines, equipment and systems technologies, as well as air transport operations, for reducing greenhouse gases, local pollution and noise.

AIAA / 3AF ANERS

The Association Aéronautique et Astronautique de France (AAAF) and the American Institute of Aeronautics and Astronautics (AIAA) are pleased to announce that the 8th edition of the Aircraft Noise and Emissions Reduction Symposium (ANERS) will occur on 25-28 February 2020 in Bordeaux, France.

Supporting the development of a long-term vision, the objective of this high-level technical Symposium is to review challenges and opportunities faced by manufacturers, local communities, air carriers, airports, governmental institutions, and non-governmental organizations in addressing noise and emissions abatement and to discuss holistic solutions that will alleviate the pressures associated with air traffic.

CEAS Air & Space

The Council of European Aerospace Societies (CEAS) is pleased to announce that its 7th Air & Space Conference is embedded in the first European Aerospace Conference to be held in Bordeaux.

Today space has become everyday infrastructure, and much more besides. Space enables activities and gives access to information of a very diverse nature, delivering pure economic value as well as societal benefits of short, medium and long duration for all European citizens. Space 4.0 represents the evolution of the space sector into a new era. To meet the challenges in front of us and to pro-actively develop the different aspects of Space 4.0, the European space sector must become globally competitive. The integration of space into the European society and economy shall be maximized and European autonomy in accessing and using space in a safe, secure, clean and green environment shall be secured, parallel to the provision of excellence in space science and technology.

The deployment of connected objects is transforming the aeronautics industry. This affects the manufacturing process with new tools and services that will reduce production costs The European aeronautics industry is investing both in technology and skills to sustain its position in a global market. The Internet of Things is a key enabler of the Industry 4.0 trend. The trend is building on digital technologies like Big Data, Artificial Intelligence and digital practices like cooperation, mobility and open innovation.

Representing Europe's foremost aeronautics & space community (Aerospace Europe) it is our aim to further the advancement of aerospace sciences and engineering by addressing the topics mentioned below at the conference.

The core theme of AEC2020 is **GREENER Aerospace**.

AEC2020 **TOPICS**

AERONAUTICS

- Aerodynamics, laminarity
- Materials & Structures
- Propulsion, including emissions reduction
- Aircraft Noise reduction - External Noise and Internal noise
- New aircraft configurations (special session)
- Electric and hybrid aircraft
- On board energy management
- Alternative fuels and power sources
- Ecodesign and green life cycle
- Urban air mobility and its impact on the environment
- Autonomous Aircraft and its impact on environment (AI, connectivity...)
- Green and safe systems & operations
- Evaluation of environmental impact
- Research infrastructures for greener and safer aviation

SPACE

- Materials and Advanced Manufacturing for Space Applications
- Aero-thermo-dynamics
- Clean Space, Space Debris
- Environmental Control & Life Support in Space
- Guidance, Navigation and Control GNC
- Structures, Thermal and Mechanisms
- Mission Design and Space Systems
- Software and Avionics
- Optics, Optoelectronics and Photonics
- Power
- Robotics
- Spacecraft Design
- Space Propulsion (green propellants)
- Satellite Communications
- Satellite Operations
- Testing

COMMITTEES

STEERING COMMITTEE

Chair: Christian **MARI**
3AF / former Safran, member of the Clean Sky SciCom

Members:

Pierre **BESCOND**	3AF
Rafael **BUREO DACAL**	ESA/ESTEC
Christophe **HERMANS**	CEAS
Dominique **NOUAILHAS**	3AF / former ONERA

AERONAUTICAL PROGRAM COMMITEE

Advisor: Eric **DAUTRIAT**
3AF / former Clean Sky Executive Director

Co-chairs:

Dominique **NOUAILHAS**	3AF / former ONERA
John-Paul **CLARKE**	Georgia Tech
Dominique **COLLIN**	Safran Aircraft Engines
Valérie **GUENON**	Safran

Committee Members (Greener Aviation & ANERS Conferences):

S. **ANDRIEUX**	ONERA
P. **BEAUMIER**	ONERA
C. **BEERS**	NLR
F. **BOUDJEMAA**	Safran
M. **BOURGOIS**	Eurocontrol
L. **BRAGA CAMPOS**	IST Univ. Lisbon
J.-F. **BROUCKAERT**	Clean Sky
M. **CAZALENS**	Safran
S. **CHERNYCHEV**	Tsagi
M. **CHIDA**	SESAR
F.S. **COLLIER**	NASA
I. **DIMINO**	CIRA
D. **DIMITRIU**	MMU
T. **GRABOWSKI**	TU Warsaw
F. **GRASSO**	CNAM
P. **HECKER**	Braunschweig Univ.
J. **HILEMAN**	FAA
C. **HILLENHERMS**	DLR
O. **HUSSE**	Airbus
R. **ILG**	Fraunhofer
M. **KACEM**	GARDN
F. **KAFYEKE**	Bombardier
T. **KRYSINSKI**	Airbus HC
M. **KYRIAKOPOULOS**	EC DG RTD
R. **LAFONTAN**	Airbus
J. **LERY**	Dassault Aviation
T. **MELIN**	FOI
J. **MELKERT**	TU-Delft
C. **NAE**	INCAS
A. **NEWBY**	Rolls Royce
W. **OSTACHOWICZ**	Polish Academy of Sciences
S. **PANTELAKIS**	EASN/Patras University
P. **PIOT**	Dassault Aviation
M. **PROTTI**	Alenia
T. **ROETGER**	IATA
V. **SLIVESTRU**	COMOTI
J.-L. **STREQUE**	Thales Avionics
G. **WAY**	Rolls Royce
U. **ZIEGLER**	FOCA

SPACE PROGRAM COMMITEE

Advisor: Torben **HENRIKSEN** ESA/ESTEC

Co-chairs:

Rafael **BUREO DACAL**	ESA/ESTEC
Christian **HÜHNE**	DLR
Philippe **LANDIECH**	CNES
Dominique **RIBEREAU**	ArianeGroup / 3AF

Committee Members:

F. **BERNELLI ZAZZERA**	Politec. Milano
C. **BONNAL**	CNES
P. **CORBERAND**	ADS
R. **DENOS**	EC DG GROW
A. **FERNANDEZ**	ESA/ESTEC
J. **FUCHS**	ESA/ESTEC
A. **GERNOTH**	ESA/ESTEC
K. **HANNEMAN**	DLR
S. **LEGRAND**	TAS
X. **LOBAO**	ESA/ESTEC
K. **PFAAB**	CNES
O. **PIN**	ESA/ESTEC
M. **PFITZNER**	UNIBW
C. **REESE**	OHB
J. **STEELANT**	ESA/ESTEC
S. **THEIL**	DLR
J. **THOEMEL**	GomSpace
J.-L. **VERANT**	ONERA
N. **VIOLA**	Politecnico di Torino

www.aerospace-europe2020.eu

ABSTRACT SUBMISSION

- The main purpose of the abstract is to give the Program Committees information to assist them in selecting the papers to be presented at the conference.
- The selected papers will be presented in a 20 minutes speech at the conference (included 5 minutes for Q&A).
- An abstract will be selected based on the importance and originality of the subject addressed, on its relevance to the conference theme, on the clarity of its expression.
- The abstract should be a "stand alone" summary that can be used in the compilation of abstracts.
- The abstract should be in English and no longer than 400 words.
- The abstract should summarize the main objectives of the paper to be presented and outline its conclusions.
- Work that has been presented elsewhere, and not updated, will be considered inappropriate.
- Notification by the Programme Committees will be accompanied by detailed instructions allowing authors to prepare and make the online submission of their full paper.
- Failure to comply with the deadlines and instructions required will entail not having the manuscript selected and included in the conference proceedings.
- All abstracts should be submitted on www.aerospace-europe2020.eu (from March 2019 to May 2019).

CONFERENCE DEADLINES

Abstract submission	31 May 2019
Notification to speakers	15 July 2019
Preliminary program	02 September 2019
Full paper submission	25 November 2019

CONFERENCE DATES

25 - 27 February 2020	Conference sessions
28 February 2020	Technical visits

VENUE

The Aerospace Europe Conference (AEC2020) will be held :

Bordeaux Congress Centre
Rue Jean Samazeuilh - 33070 Bordeaux -France

LANGUAGE

Please note that the official language for the conference will be English.
All presentations and documents must be in English.

AEC2020 SECRETARIAT

3AF - 6 rue Galilée - 75116 PARIS - France - Tel.: +33 (0)1 58 64 12 30
Email: aec2020@3af.fr - www.aerospace-europe2020.eu

CO-ORGANISED BY :

CEAS Council of European Aerospace Societies — 3AF Association Aéronautique et Astronautique de France — AIAA

WITH THE SUPPORT OF :

Clean Sky 2 — esa — SESAR

www.aerospace-europe2020.eu

AMONG UPCOMING AEROSPACE EVENTS

2019

MAY

02-03 May – FSF – **64th Business Aviation Safety Summit – Denver, Colorado (USA)** – https://flightsafety.org/events

07-09 May – AIAA – **AIAA Defense Forum – Defense and Security Forum – Laurel, MD (USA)** – www.aiaa.org/Events

13-17 May – ESA – **Living Planet Symposium 2019 – How EO contributes to science and society, how disruptive technologies and actors are changing the traditional EO landscape** – Milano (Italy) – Milano Congressi – https://www.esa-conferencebureau.com

14-16 May – RAeS – **WATS2019 – World Aviation Training Summit –** Orlando, FL (USA) – https://www.aerosociety.com/events-calendar/

20-23 May – AIAA/CEAS – **Aeroacoustics 2019 – 25th AIAA/CEAS Aeroacoustics Conference** – Delft (NL) – TU delft – www.aiaa.org/events/

21-23 May – EBAA – **EBACE 2018 – European Business Aviation Conference and Exhibition** – Geneva (Switzerland) – Geneva's Palexpo – http://ebace.aero/2019/

27-29 May – Elektropribor – **26th Saint Petersburg International Conference on Integrated Navigation Systems (ICINS2019)** – Saint Petersburg (Russia) – www.elektropribor.spb.ru/icins2019/en

27-30 May – European Commission – **AERODAYS2019 – Europe's Technological Achievements for a Sustainable Future of Aviation – Bucharest (Romania)** – Romanian Palace of Parliament – www.tandemaerodays19-20.eu

JUNE

04-05 June - FSF – **7th Annual Safety Forum – Brussels (Belgium) –** https://flightsafety.org/events

10-13 June - IFASD – **International Forum on Aeroelasticity and Structural Dynamics 2019 –** Savannay, Georgia (USA) – Westin Savannah Harbor – https://aiaa.org/

10-14 June - SFTE – **50th SFTE (Society of Flight Test Engineers) International symposium –** Toulouse (France) – www.sfte.org

11-12 June - RAeS – **The Future Reality of Flight Simulation Conference 2019** – London (UK) – RAeS/HQ – https://www.aerosociety.com/events-calendar/

11-13 June - 3AF/SEE – **ETTC 2019 – European Test and Telemetry Conference – Toulouse (France)** – http://www.ettc2019.org

12-14 June - AIAA – **TiS2019 – The 6th International Conference on Tethers in Space – Madrid (Spain)** – Universidad Carlos III de Madrid - www.aiaa.org/Events - http://eventos.uc3m.es/go/TiS2019

16-20 June - ESA/DLR – **24th ESA Symposium on European Rocket and Balloon Programmes and Related Researches –** Essen (Germany) – Atlantic Congress Essen, Messeplatz, 3 – https://www.esaconferencebureau.com

17-21 June - AIAA – **AIAA Aviation Forum – AIAA Aviation and Aeronautics Forum and Exposition –** Dallas, TX (USA) - www.aviation.aiaa.org/

17-23 June - SIAE – **International Paris Air Show (IPAS) –** Le Bourget (France) – https://www.siae.fr

18-20 June - EASN/GMI Aero – **CPD Seminar – Bonded Composite Repair of Aircraft Structures – Paris (France)** – www.gmi-aero.fr

JULY

01-04 July – EUCASS – **EUCASS 2019 – 2019 Edition of the biennial European Conference on AeroSpace Sciences** - Madrid (Spain) – Universidad Politecnica de Madrid (UPM) – https://eucass.eu

AUGUST

19-23 August – AIAA – **AIAA Propulsion and Energy Forum and Exposition** – Indianapolis, IN (USA) – www.aiaa.org/events

SEPTEMBER

03-05 September – EASA – **Area 100 KSA Workshop – Cologne (Germany)** – EASA/HQ – https://www.easa.europa.eu/

03-06 September – EASN – **9th International Conference on Innovation in Space & Space – Athens (Greece)** – National Center for Science Research Demokritos (NSCR) – Agia Paraskeir – https://www.easn.net

04-06 September – ESA/ETH Zürich – **7th International Conference on Scientific and Fundamental**

AMONG UPCOMING AEROSPACE EVENTS

Aspects of GNSS – Zûrich (Switzerland) – ETH Zûrich – https://atpi.eventsair.com/

09-12 September – AIDAA – **XXV International Congress AIDAA** – Rome (Italy) – Faculty of Civil and Industrial Engineering of the Sapienza University of Rome – https://www.aidaa2019.com

17-19 September – ERF/CEAS – **ERF2019 – 45th European Rotorcraft Forum** – Warsaw (Poland) – Warsaw University of Technology – www.erf2019.pw.edu.pl

18-19 September – RAeS – **International Flight Crew Training Conference** – London (UK) – RAeS/HQ – https://www.aerosociety.com/events-calendar/

24-26 September – SAE International – **AEROTECH Europe Congress & Exhibition – Bordeaux (France)** – https://sae.org/

24-27 September – ESA – **TTC2019 – 8th ESA International Workshop on Tracking, Telemetry and Command Systems for Space —** Darmstadt (Germany) – ESA/ESOC – https://atpi.eventsair.com/

30 September/**03** October – ESA – **FAR2019 – Flight Vehicles Aerothermodynamics and Re-Entry Missions & Engineering –** Monopoli (Italy) – https://atpi.eventsair.com/

30 September/**04** October – ESA – **ESPC2019 – 12th European Space Power Conference –** Juan-les-Pins (France) – https://atpi.eventsair.com/

OCTOBER

05-20 October – Seoul – **Seoul Adex 2019 – Seoul International Aerospace and Defense Exhibition 2019** – Seoul (South Korea) – Seoul Airport – Seongnam Air Base – www.milavia.net/airshows

08-09 October – FTF – **Aerospace Technology Congress 2019 – Sustainable Aerospace Innovation in a Globalised World – Stockholm (Sweden)** – Stockholm Waterfront Congress Centre – www.FT2019.SE

15-17 October – IATA – **Global airport and Passenger Symposium 2019 – Warsaw (Poland)** – https://www.iata.org/events/

15-17 October – Aviationweek – **MRO-EUROPE – Maintenance and Repair Overhaul Conference and Exhibition – London (UK)** – https://mroeurope.aviationweek.com

15-20 October – Seoul – **Seoul Adex 2019 – Seoul International Aerospace and Defense Exhibition 2019** – Seoul (South Korea) – Seoul Airport – Seongnam Air Base – www.milavia.net/airshows

21-25 October – IAC – **70th International Astronautical Congress** – Space: The Power of the Past, the Promise of the Future Washington, D.C.(USA) – Convention Center – www.iac2019.org/

NOVEMBER

04-06 November – **72nd annual International Air safety Summit – Taipei (Taiwan)** – https://www.flight-safety.org/events

04-08 November – COSPAR – **4th COSPAR Symposium – Small Satellites for Sustainable Science and Development** – Herzliya (Israel) – Hotel Daniel – http://www.cospar2019.org/

06-09 November – ESA – **7th Intenational Conference on Astrodynamics Tools and Techniques (ICATT)** – Oberpfaffenhofen (Germany) – DLR Centre – https://www.esaconferencebureau.com

17-21 November – Dubai DWC – **Dubai Airshow 2019 – Connecting the Aerospace Industry** – Dubai – UAE) – Dubai World Central – Al Maktoum, Jebel Ali – www.dubaiairshow.aero

2020

JANUARY

06-10 January – AIAA – **AIAA SciTech Forum – AIAA Science and Technology Forum and Exposition –** Orlando, FL (USA) – https://www.aiaa.org/events/

FEBRUARY

25-28 February – CEAS/3AF – **AEC2020 – AREOSPACE EUROPE CONFERENCE** - Thematic: Greener Aerospace innovative Technologies and operations for a human Friendly Environment – Bordeaux (France). Congress Center www.aerospace-europe2020.eu

MARCH

07-14 March – IEEE/AIAA – **2020 IEEE Aerospace Conference –** Big Sky, Montana (USA) – https://www.aiaa.org/events

APRIL

19-23 April – CEAS – **HISST –** Bruges (Belgium) –

BULLETIN
AEROSPACE
EUROPE

AMONG UPCOMING AEROSPACE EVENTS

MAY
13-17 May – ILA – **ILA Berlin 2020 – Innovation and Leadership in Aerospace –** Berlin (Germany) – BER Airport – ExpoCentre Airport
https://www.ila-berlin-de/en

JULY
13-17 July – ECCOMAS – **ECCOMAS Congress 2020 – Jointly organized with the 14th World Congress on Computational Mechanics** – Paris (France)
www.eccomas.org/

20-26 July – Farnborough – **Farnborough International Airshow 2020 –** Farnborough (UK - Show Centre, ETPS Rd – Farnborough GU14 6FD
https://www.farnboroughairshow.com/

AUGUST
15-23 August – COSPAR –**43rd COSPAR Scientific Assembly** – Sydney (Australia) – International Convention Centre – https://www.cospar2020.org

SEPTEMBER
20-26 September – ICAS – **32nd Congress of the ICAS –** Shanghai (China) – https://www.icas.org/calendar.html

Save the date!!

TandemAEROdays19.20 – Bucharest event

May 27-30, 2019 – Romanian Palace of Parliament

Europe's Technological Achievements for a Sustainable Future of Aviation

© SIAE 2017 - Anthony Guerra & Alex Marc