



# Introduction to SESAR exploratory research activities

Peter Hotham, Deputy Executive Director, SESAR Joint Undertaking

13 March 2019, World ATM Congress



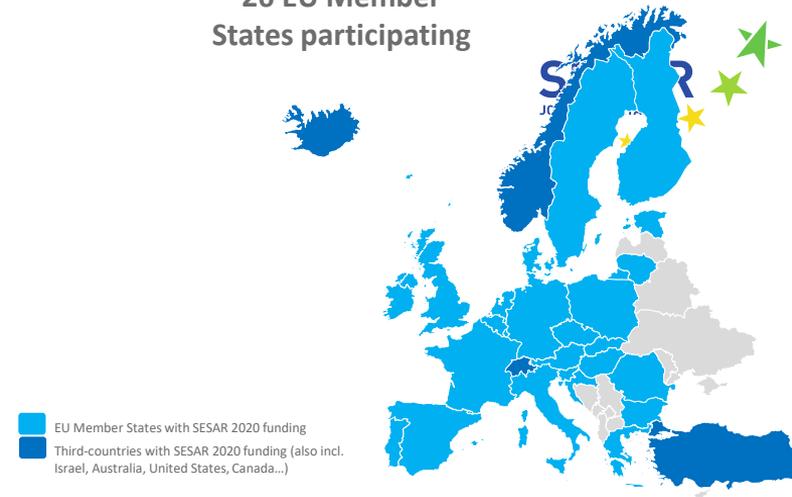
founding members



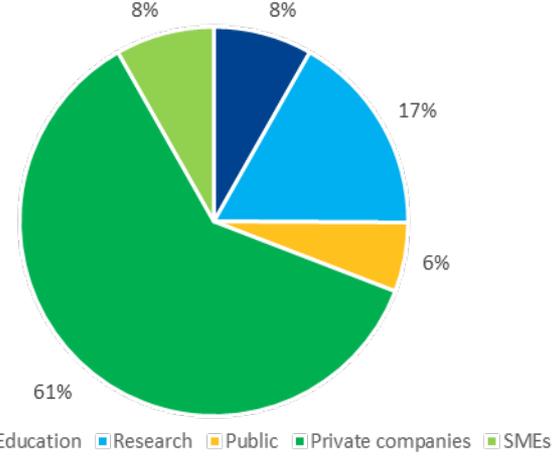
# GROWING COMMUNITY OF SESAR JU STAKEHOLDERS & BENEFICIARIES



26 EU Member States participating



Types of beneficiaries (Sept. 2018)



# SESAR INNOVATION PIPELINE

*Air traffic management  
research & innovation  
2018 highlights*



EXPLORING THE  
BOUNDARIES OF  
ATM RESEARCH

DELIVERING  
SESAR  
SOLUTIONS

DEMONSTRATING  
SESAR  
SOLUTIONS

ENABLING  
SAFE AND  
SECURE  
INTEGRATION  
OF DRONES



EXPLORATORY  
RESEARCH

Explores new concepts beyond those identified in the European ATM Master Plan or emerging technologies and methods. The knowledge acquired can be transferred into the SESAR industrial and demonstration activities.



INDUSTRIAL  
RESEARCH  
& VALIDATION

Assesses and validates technical and operational concepts in simulated and real operational environments according to a set of key performance areas. This process transforms concepts into SESAR Solutions.



VERY LARGE  
SCALE  
DEMONSTRATIONS

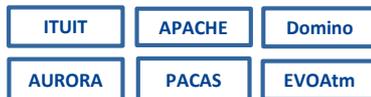
Tests SESAR Solutions on a much larger scale and in real operations to prove their applicability and encourage the early take-up of solutions.



# SESAR 2020- BEHIND THE



Knowledge transfer network



PJ22 – Validation, Verification & Demo Infrastructure

Fundamental Scientific Research	U-space
CLASS	CLASS
BigData4ATM	DREAMS
DART	TERRA
BEST	SECOPS
TaCo	IMPETUS
TBO-MET	CORUS
MINIMA	PercEvite
PNOWWA	DroC2om
AGENT	Airpass
MALORCA	PODIUM
AUTOPACE	Safedrone
ATM4E	USIS (GAP)
STRESS	GEOSAFE
COCTA	VUTURA
COMPAIR	SAFIR
Vista	GOF USPACE
	DOMUS
	DIODE
	EURODRONE

## ATM application-oriented research

## Industrial research & validation

## Very-large scale demonstration

<p>High-performing airport operations</p>	<p>ENVISION</p> <p>MOTO</p> <p>RETINA</p>	<p>PJ03a – Integrated Surface Management</p> <p>PJ03b – Airport Safety Nets</p>	<p>PJ02 – Increased Runway and Airport Throughput</p> <p>PJ04 – Total Airport Management</p>	<p>PJ05 – Remote Tower for Multiple Airport</p>	<p>PJ28 – Integrated Airport Ops (incl. TBS)</p> <p>AAL2</p> <p>AUDIO (GAP) (PJ28)</p>
	<p>Optimised ATM network services</p>		<p>PJ07 – Optimised Airspace Users Operations</p> <p>PJ08 – Advanced Airspace Management</p>	<p>PJ09 – Advanced DCB</p>	<p>PJ24 – Network Collaborative Management</p> <p>Airline Team NCM (PJ24)</p>
	<p>Advanced air traffic services</p>	<p>OptiFrame</p> <p>COPTRA</p> <p>PARTAKE</p> <p>SALSA</p> <p>R-WAKE</p>	<p>ADAPT</p> <p>COTTON</p> <p>EMPHASIS (PJ11)</p>	<p>PJ01 – Enhanced Arrivals &amp; Departures</p> <p>PJ10 – Separation Management en-route &amp; TMA</p>	<p>PJ06 – Trajectory Based Free Routing</p> <p>PJ11 – Enhanced Air &amp; Ground Safety Nets</p>
<p>Enabling aviation infrastructure</p>	<p>NAVISAS</p> <p>SAPIENT</p>	<p>GATEMAN</p>	<p>PJ14 – CNS</p> <p>PJ15 – Common services</p> <p>PJ16 – CWP/HMI</p>	<p>PJ17 – SWIM infrastructures</p> <p>PJ18 – 4D trajectory management</p>	<p>PJ.31 – Initial Trajectory Information Sharing</p> <p>PJ.31 - DIGITS-AU</p> <p>EAGLES</p> <p>PJ.27 – Flight information exchange</p> <p>GRADE</p> <p>GAINS</p>

# FEEDING THE INNOVATION PIPELINE

## Overview

- 28 ER1-projects
- 2016-2018
- 80 academic and industry partners
- European Union and EU Associated Countries (Switzerland, Norway, Iceland, Serbia, Israel, Turkey).

## ATM excellence & outreach

- Automation, robotics and autonomy
- Complexity, data science and information management
- Environment and meteorology for ATM
- Economics, legal and regulation

## ATM application-oriented research

- High-performing airport operations
- Advanced air traffic services
- Enabling aviation infrastructure
- ATM operations, architecture, performance and validation

## Exploring the boundaries of air traffic management

A summary of SESAR  
exploratory research results

2016-2018





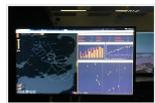
# GROWING RECOGNITION FOR EXPLORATORY RESEARCH RESULTS



[RESULT IN BRIEF] [Better winter weather forecasts for airports](#)  
EU-funded researchers developed up to the minute probabilistic forecasts for winter weather that enable air traffic and airport operators to make their operations more efficient and to mitigate risks.  
**Programme:** H2020-EU.3.4.7.1  
**Record Number:** 239886  
**Last updated on:** 2018-10-05  
**Available languages:** [DE](#), [EN](#), [ES](#), [FR](#), [IT](#), [PL](#) [Booklet](#)



[RESULT IN BRIEF] [Speech recognition technology for air traffic controllers](#)  
The popularity of air transport continues to grow, placing an even greater workload on air traffic controllers (ATCOs). Their predicament can be improved through an automatic speech recognition system closely integrated with an arrival manager developed by EU and SESAR funded...  
**Programme:** H2020-EU.3.4.7.1  
**Record Number:** 239630  
**Last updated on:** 2018-09-24  
**Available languages:** [DE](#), [EN](#), [ES](#), [FR](#), [IT](#), [PL](#) [Booklet](#)



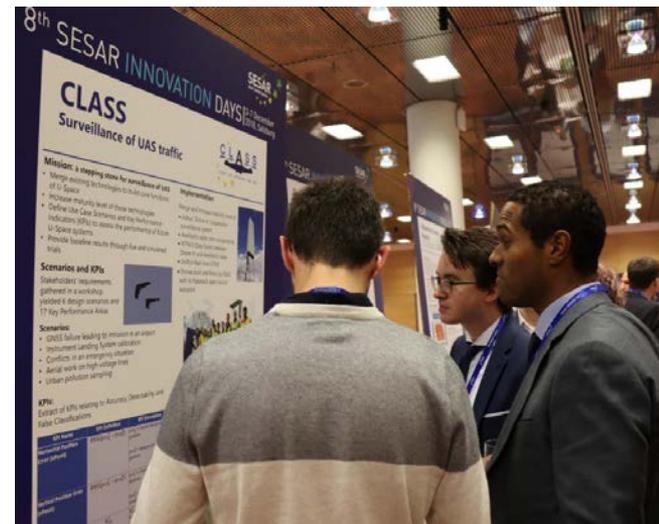
[RESULT IN BRIEF] [Air traffic management for the future](#)  
An automated system developed by EU-funded scientists can help air traffic control coordinate departures and reduce the probability of conflicts without reducing air space capacity, while preserving airline preferences.  
**Programme:** H2020-EU.3.4.7.1  
**Record Number:** 239575  
**Last updated on:** 2018-09-17  
**Available languages:** [DE](#), [EN](#), [ES](#), [FR](#), [IT](#), [PL](#) [Booklet](#)

# SESAR INNOVATION DAYS

The flagship event for ATM research

- Poster presentations
- Peer reviewed papers
- Young Scientists Award
- Debates
- Networking
- Site visits

2019 edition –  
save the date!  
2-6 December  
2019, Athens



# NURTURING TOMORROW'S TALENT

## 1<sup>st</sup> place: Gianluca Di Flumeri

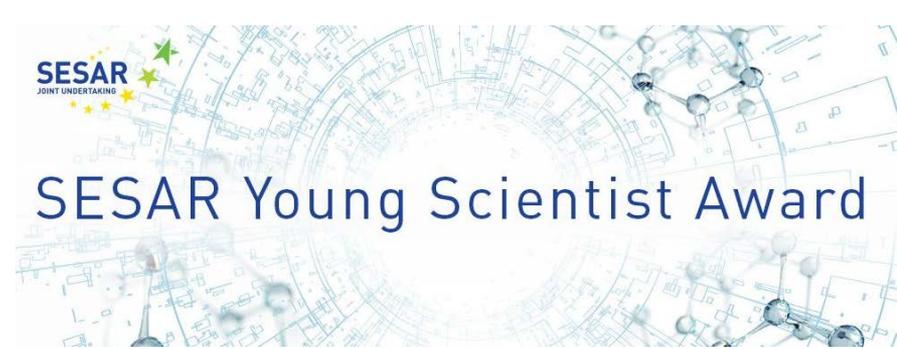
Electroencephalography-based measures of mental workload for the development of passive brain-computer interfaces for use in operational environments

## 2<sup>nd</sup> place: Riccardo Patriarca

Risk and safety management for sociotechnical systems: From Newtonian reasoning to resilience engineering

## 3<sup>rd</sup> place: Goran Pavlovic

Airport pair-route charging system





# Importance of knowledge transfer

Georg Trausmuth, Engage Network

13 March 2019, World ATM Congress



founding members



# Overview



- The consortium
- What the KTN is about
- Thematic challenges at the core
  - [join our next workshop](#)
- Industry partners
  - [how to get involved](#)

# The consortium

A mix of industry and academia; 2018-2021



Engage



FREQUENTIS



[engagektn.com](http://engagektn.com)

 [twitter.com/EngageKTN](https://twitter.com/EngageKTN)

# What the KTN is about

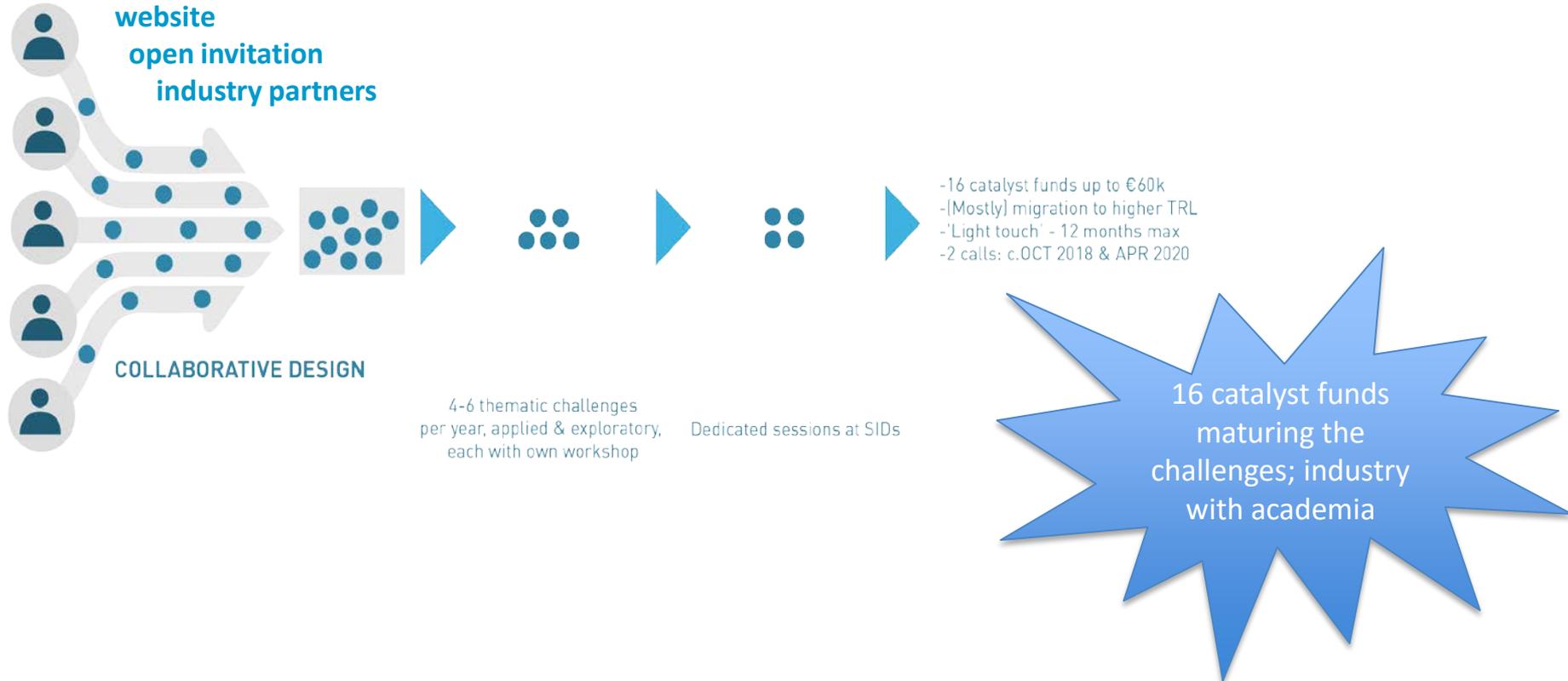
## Core objectives and activities



- Better integrate more applied/industrial & exploratory research (**two-way process**)
  - mutual benefit, integrated into the KTN fabric, funded; interdisciplinary
- Education and training: future ATM skilled workforce
  - “develop new talent with a deep knowledge of the future ATM scientific research needs ... stimulating the next generation of ATM staff”
  - supporting 11 PhDs (launching in April 2019) (nearly all with (industry) co-funding)
  - 3 summer schools; ATC training courses; lecture programmes at the ‘grass roots’ level
  - SESAR Innovation Days
- Knowledge hub (wiki) as a ‘go-to’ source, single point of entry for ATM knowledge
  - popular demand: improved search functionality; consolidated repository
- Not only larger concepts, but sum of large number of support actions
  - multiple grants (e.g. for student mobility, industry speakers at events); ‘light touch’ approach

# Thematic challenges at the core

## New research threads that permeate the KTN



# Thematic challenges at the core

## New research threads that permeate the KTN

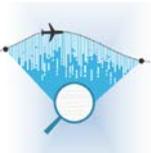


### #1. CNS vulnerability and security

27 March 2019, SJU, Brussels

Contact point: Paula López, Innaxis

Few places left!  
Free registration on website



### #2. Data-driven trajectory prediction

06 November 2018, UPC, Barcelona

Contact point: Dirk Schaefer, EUROCONTROL

More in 2019



### #3. Efficient use of MET data

13 November 2018, SJU, Brussels

Contact point: Tatjana Bolić, University of Trieste

More in 2019



### #4. Novel market mechanisms in ATM

25 October 2018, UoW, London

Contact point: Andrew Cook, University of Westminster

More in 2019



[engagektn.com](http://engagektn.com)

 [twitter.com/EngageKTN](https://twitter.com/EngageKTN)

# Industry partners

## Current partners (>50, ...)



- Advanced Logistics Group (ALG)
- AGIFORS - Airline Group of the International Federation of Operational Research Societies
- Air Traffic Controllers European Unions Coordination (ATCEUC)
- airBaltic
- Airport Regions Conference (ARC)
- American Airlines
- ANS CR
- Aslogic
- Association for the Scientific Development of ATM in Europe (ASDA)
- Autoridade Nacional da Aviação Civil (ANAC)
- Barcelona Supercomputing Center (BSC)
- Belgocontrol
- Boeing Research and Technology Europe (BR&T-Europe)
- Bundesluftfahrt für Flugsicherung (BAF)
- Civil Aviation Authority (CAA)
- COOPANS Consortium
- Department for Transport (UK)
- Direction des Services de la Navigation Aérienne (DSNA)
- Direktorat civilnog vazduhoplovstva Republike Srbije (DCV)
- European Meteorological Services Network (EUMETNET)
- European Passengers' Federation (EPF)
- Executive Airlines
- Ferrovial Agroman
- Finnair
- FlightGlobal
- Flughafen München / Munich Airport
- Gestair SL
- Helios
- HEMAV - High Endurance Multipurpose Aerial Vehicles
- Honeywell Aerospace
- HungaroControl
- Icelandair
- IFSTAR - Institut Français des Sciences et Technologies des Transports, de l'Aménagement et des Réseaux
- INFORM - Institut für Operations Research and Management GmbH
- International Air Transport Passenger Association (IATPA)
- International Federation of Air Traffic Controllers' Associations (IFATCA)
- Irish Aviation Authority (IAA)
- LfV - Luftfahrtsverket
- London Luton Airport
- Lufthansa Systems
- Manchester Airport
- NATS
- Naviair
- Network Manager - nominated by the European Commission
- NEXTOR II Consortium - University of California, Berkeley and University of Maryland
- PACE Aerospace Engineering & Information Technology
- Pegasus Airlines
- QinetiQ Ltd
- Raytheon UK
- Sabre Airline Solutions
- SWISS - Swiss International Air Lines
- Thomas Cook Airlines
- TÜBITAK - The Scientific and Technological Research Council of Turkey
- Turkish Airlines



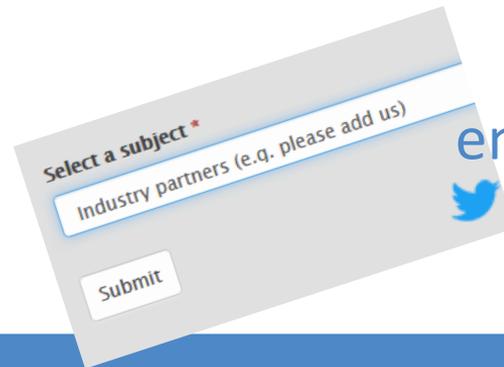
# Industry partners

## Why join?



- Immediate access to planning and **shaping future research** needs
- **Funding to participate in workshops** and to join other events, such as SESAR Innovations Days
- Participate in the Engage Awards Board, e.g. for future funding proposals
- Get involved with reviews of conference and journal papers ... the very latest ideas in your domain
- Integrate with bright young minds, PhDs, building solutions for tomorrow
- Offer **industry placements**, get involved in exchanges and **recruitment activities**
- **Propose new thematic challenges** where basic research can be **matured to higher TRLs**
- Help to build **ATM concepts roadmap** – what pieces are missing/needed regarding industry needs?

Please visit the  
website!



[engagektn.com](http://engagektn.com)

 [twitter.com/EngageKTN](https://twitter.com/EngageKTN)



Introduction to the SESAR  
Knowledge Transfer Network: Engage

---

Thank you



founding members





# Electroencephalography-based measurement of controller mental workload

Gianluca Di Flumeri, Sapienza University Rome

13 March 2019, World ATM Congress



founding members



# An error could have dramatic consequences

- More than **70% of aviation accidents are due to human errors**, most of them caused by operators' (traffic controllers, pilots) overload or mental status impairment.
- Over **1.2 million people die each year on the world's roads**, millions more sustain serious injuries affecting their whole life. **Human error is the main cause** of the 57 % of road accidents and contributing factor in over 90 % of them.
- **Medical errors cause high people mortality**, about 100.000 people per year only in USA. Furthermore, about the 10 % of hospitalized patients experienced complications on their treatments due to medical mistakes.



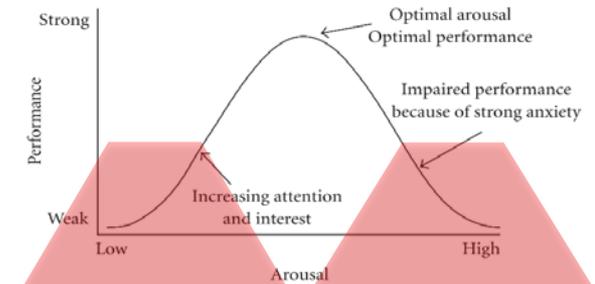
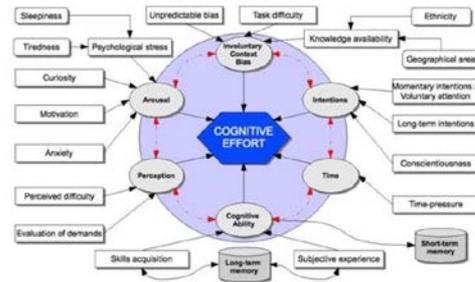
The Human Factor is  
the most important but the less controllable factor  
in operational environments.

*(WHO Report, 2015; Boeing Report, 2011)*



# A Human Factor problem

- Operator may cause an accident due to **inadequate training, unrealistic schedules, systems of compensation that encourage speeding** and consecutive hours of operation.
- Accidents caused by human error are **not** based solely on **physical impairments**: also **mental states issues** can also lead to error commission.
- **Human performance** are not constants but they depend on the actual **psychophysical state** of the operator.



QUALITATIVE	QUANTITATIVE	QUALITATIVE	QUANTITATIVE
Sufficiently frequent, but simple, narrow requirements	Mental requirements are too seldom	No time pressure but mental requirements are too complex and/or complicated	Time pressure, mental requirements are too frequent



Boredom, monotony

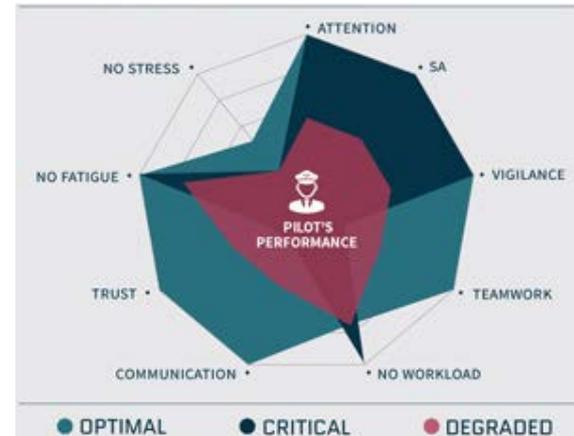


Mental fatigue  
(in case of extreme frustration, combination with anxiety possible)

# The Human Performance Envelope

- Human performance degradation results from the interaction of multiple HFs and this interaction is still mostly underexplored.

The concept of **Human Performance Envelope (HPE)**, a function defined by relevant HFs and associated scales, aims **to predict operator's performance** defining a region where performance will be tolerable, and where it starts to become hazardous (*H2020 Future Sky Safety program*).



One of the **current limitations** is the **lack of objective information about the operator's psychophysiological status** while dealing with operative activities.



**Lack of objective information about the operator's psychophysiological status** while dealing with operative activities.



- ! Self-assessed measures are subjective and cannot be collected while operating. Also, the operator could be not aware of an incoming psychophysiological impairment.
- ! Supervisor assessment could have a certain subjective bias. Also, sometimes human state degradation could be covert (i.e. not perceivable from his behaviour).
- ! System data often highlight risky behaviours “after the fact”.

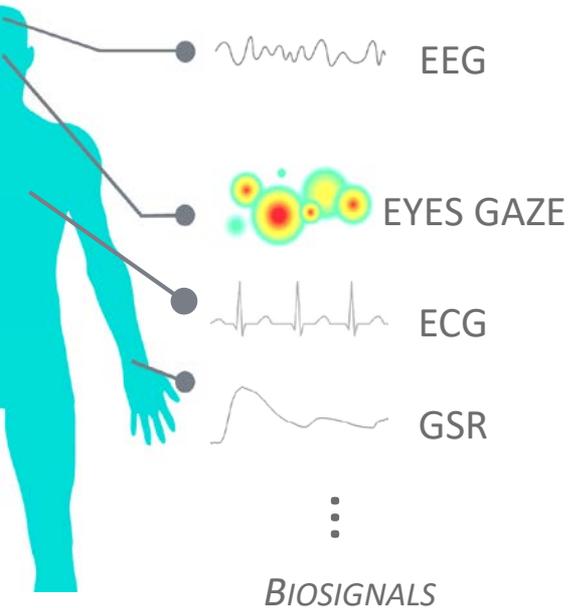


**Neurophysiological measures could provide objective information about human mental states.** The assessment of the different mental states would allow to solve the Human Factor issue related to the **HPE characterization**.

*(Parasuraman et al., 2008; Borghini et al., 2017)*

# The concept

Cognitive Neuroscience applied to aviation and operational environments



**BIOSIGNAL  
PROCESSING**



OPERATOR'S  
PSYCHOPHYSIOLOGICAL STATE



**Neurophysiological metrics of Human Factor Components**

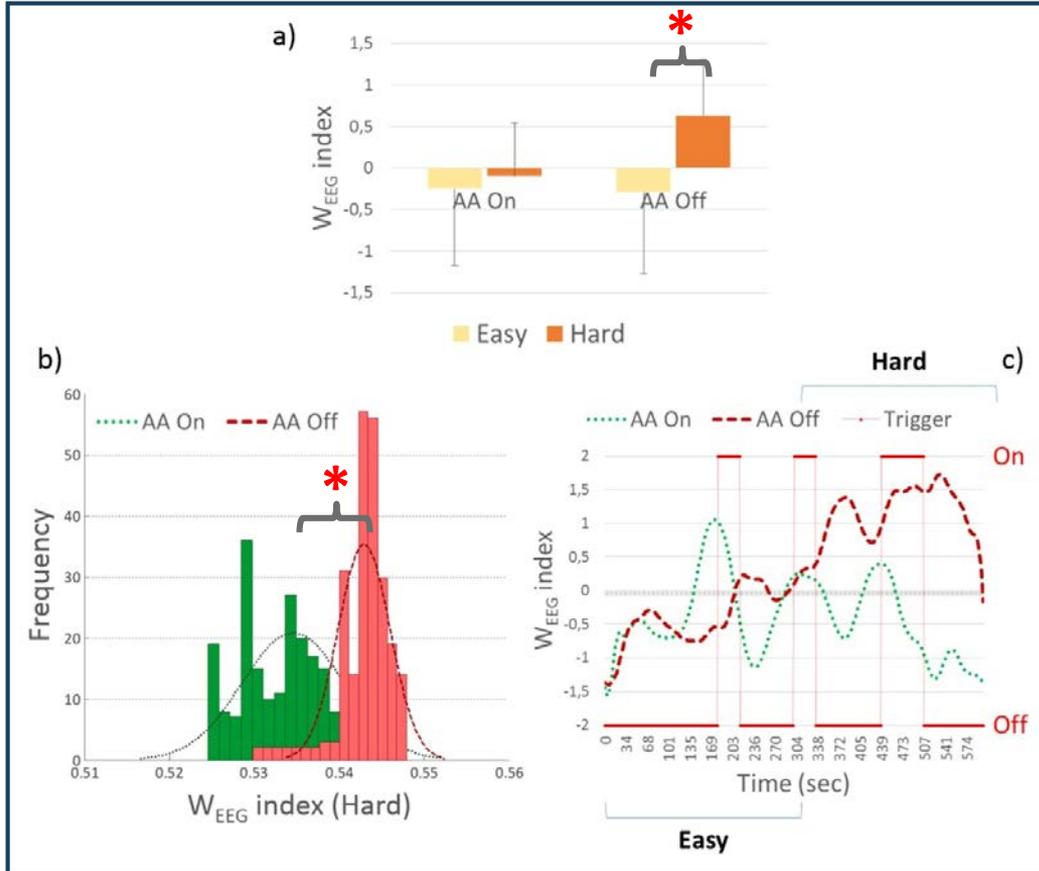
# Mental workload and adaptive automation



12 student ATCOs ( $23 \pm 2$  years old).

- ✓ EEG with 9 electrodes
- ✓ 2 testing scenarios of 15 minutes (5 mins EASY, 5 mins MEDIUM, 5 mins HARD):
  1. Adaptive Automation off (AA off);
  2. Adaptive Automation on (AA on) → **online testing**
- ✓ High realistic settings:
  - Real workstation, realistic simulation scenario normally used for training, 2 aircraft pseudo-pilots.

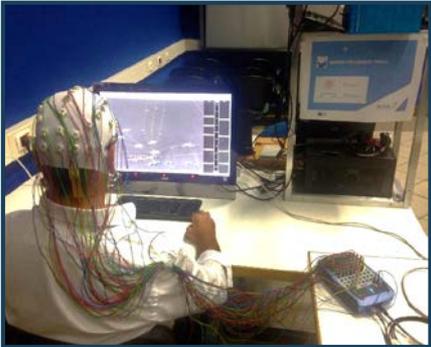
# Mental workload and adaptive automation



- The t-tests showed a **significant increasing** ( $p = 0.03$ ) of the  $W_{EEG}$  indexes distribution between the Easy and the Hard periods **only for the AA Off condition**.
- The shape of the  $W_{EEG}$  distributions related to the Hard slot, for both the two conditions (AA On/Off). **The AA On indexes were significantly** ( $p = 0.04$ ) **lower than during the AA Off scenario**. No differences between the Easy condition.
- Time course of the  $W_{EEG}$  index, during both the two scenarios (AA On/Off), with the AA activation segments (Trigger) for a representative subject.

(Aricò et al., 2016. *Frontiers in Human Neuroscience*)

# Vigilance and adaptive automation



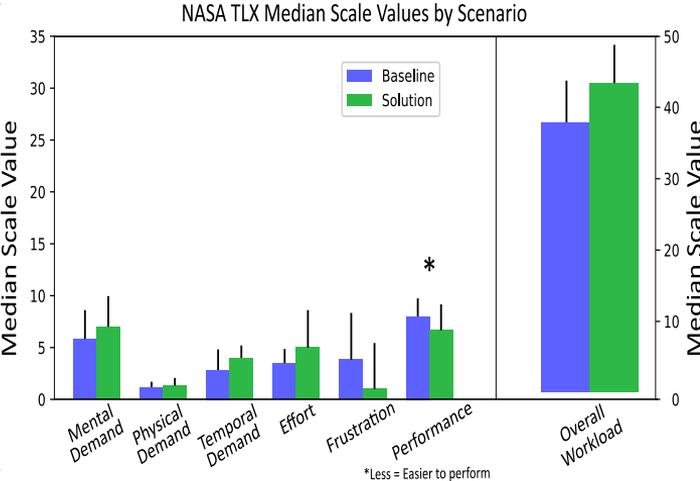
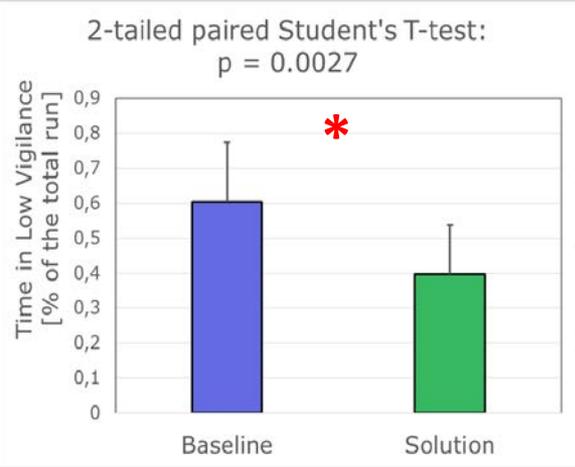
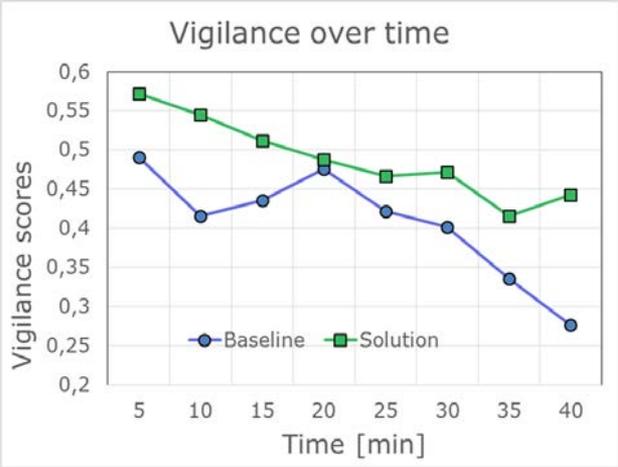
- 14 professional ATCOs (Age:  $45.0 \pm 7.5$  years)
- 15-channels EEG data
- 2 realistic ATM scenarios (BASELINE and SOLUTION)
- Eye-tracking device also for measurements
- NASA-TLX after each experimental scenario



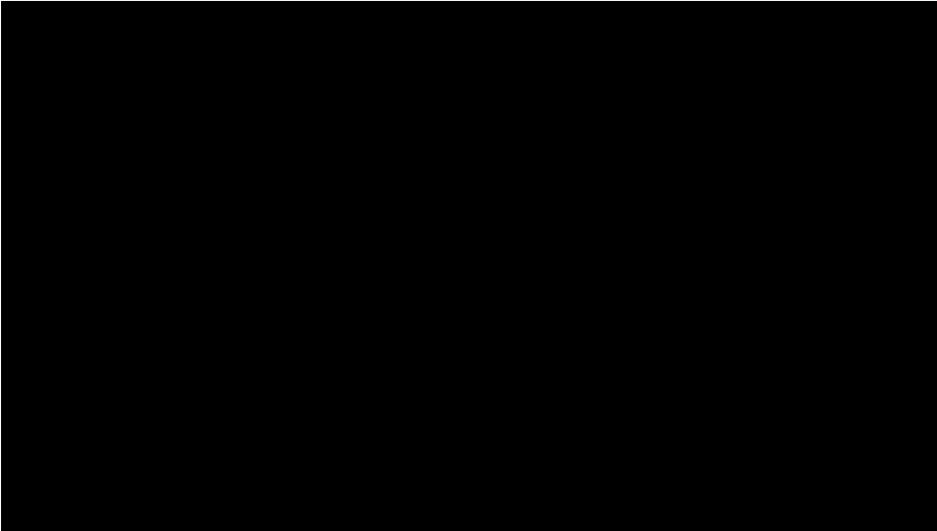
Deutsches Zentrum für Luft- und Raumfahrt  
German Aerospace Center



BRAIN Signs



# Evaluation of human-machine interaction



university of groningen





# Future trends



## Research

Obtain insights about covert and/or unconscious reasons of human behaviour.



## Industry

Human-centred design of workstations/dashboards/ cockpits.



Brain-Computer Interfaces to support operators and improve Human-Machine interaction.



**It is not science fiction,  
it is reality!**



[www.brainsigns.com](http://www.brainsigns.com)

> 30 high-impact scientific publications,  
1 patent, 1 book, various awards



Dr. Gianluca Di Flumeri, PhD  
gianluca.diflumeri@brainsigns.com

---

Thank you very much  
for your attention!



founding members





# Airport-pair charging in Europe - impacts of ATM fragmentation

Goran Pavlovic, Faculty of Transport and Traffic Engineering  
Belgrade University

13 March 2019, World ATM Congress



founding members



# Background and motivation



- Current CRCO route charging scheme – negative effect of aircraft taking detours around charging zones with higher unit rates (L. Delgado, 2015).

**Policy negatively impacting operations!**      Fuel ↑, CO<sub>2</sub> ↑, traffic shifts etc.

- Airport-pair (Origin-Destination) charging (APC) - often seen as a solution, but remains an under-researched topic in ATM community!
- SESAR Exploratory research project **COCTA**: APC taken as one of the “enablers” for the concept.
- APC opens new opportunities for innovative pricing mechanisms

# What is airport-pair charging?

## Option 1:

- independent of the chosen route between two airports
- Airport-pair charge \* mass factor

Example: FRIDAY (R. Verbeek, 2016): charged route - Great Circle Line

## Option 2:

- Airport-pair unit rate (APUR) \* mass factor \* **distance factor**
- Distance factor remains to reflect the amount of service provided
- Additional incentive to choose shortest route

## Option 3...?

# Challenges and potential solution

How to set APUR in order to recover the costs of individual Air Navigation Service Providers (ANSPs) involved in service provision for a particular airport-pair, given the uncertainty in the chosen routes?

$$APUR = \sum_{i=1}^n w_i * t_i \quad \sum_{i=1}^n w_i = 1$$

Weighted average formula:

where:

$w_i$  – estimated relative share of ANSP i in airport-pair service provision;

$t_i$  – unit rate of ANSP i (as calculated today according to CRCO methodology);

Obviously, APUR would depend on the traffic distribution over the charging zones, i.e. the APUR value would be influenced by the cost of service provision in different zones and by the level of ATM fragmentation between the observed airports.

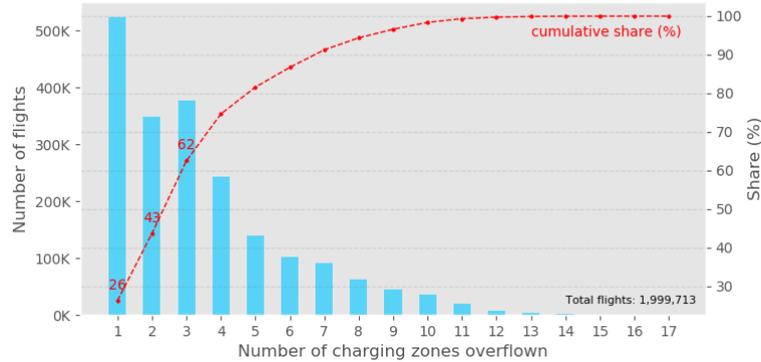
# Impact of ATM fragmentation - analysis

- Timeframe: 61 summer days (June and July 2016)
- Geographical scope: flights within, to/from Europe
- Filter: airport-pairs with  $\geq 10$  days of traffic
- Trajectory type: last-filed flight plan trajectories (Eurocontrol DDR service)

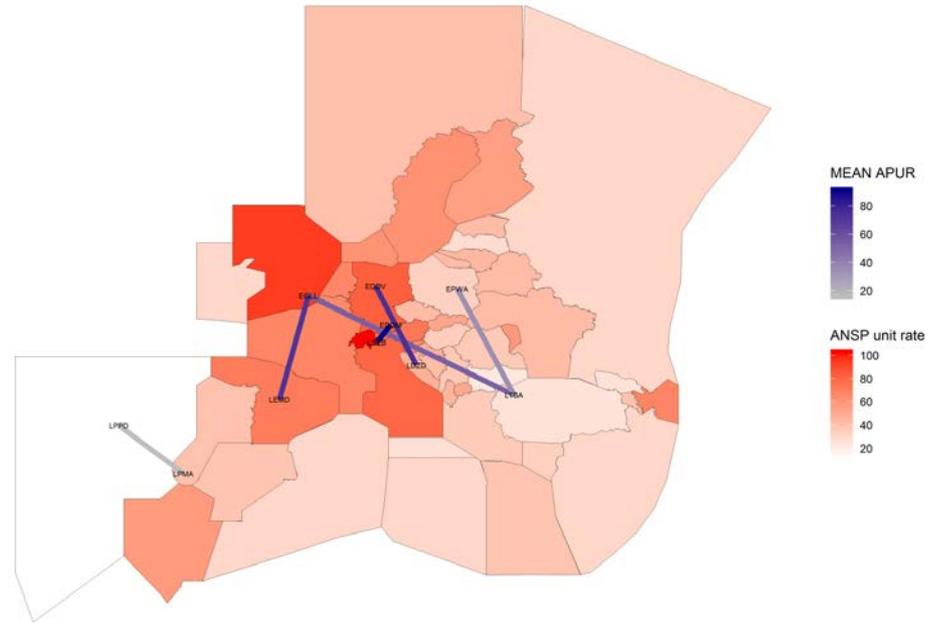


daily variability of ANSP shares and APUR

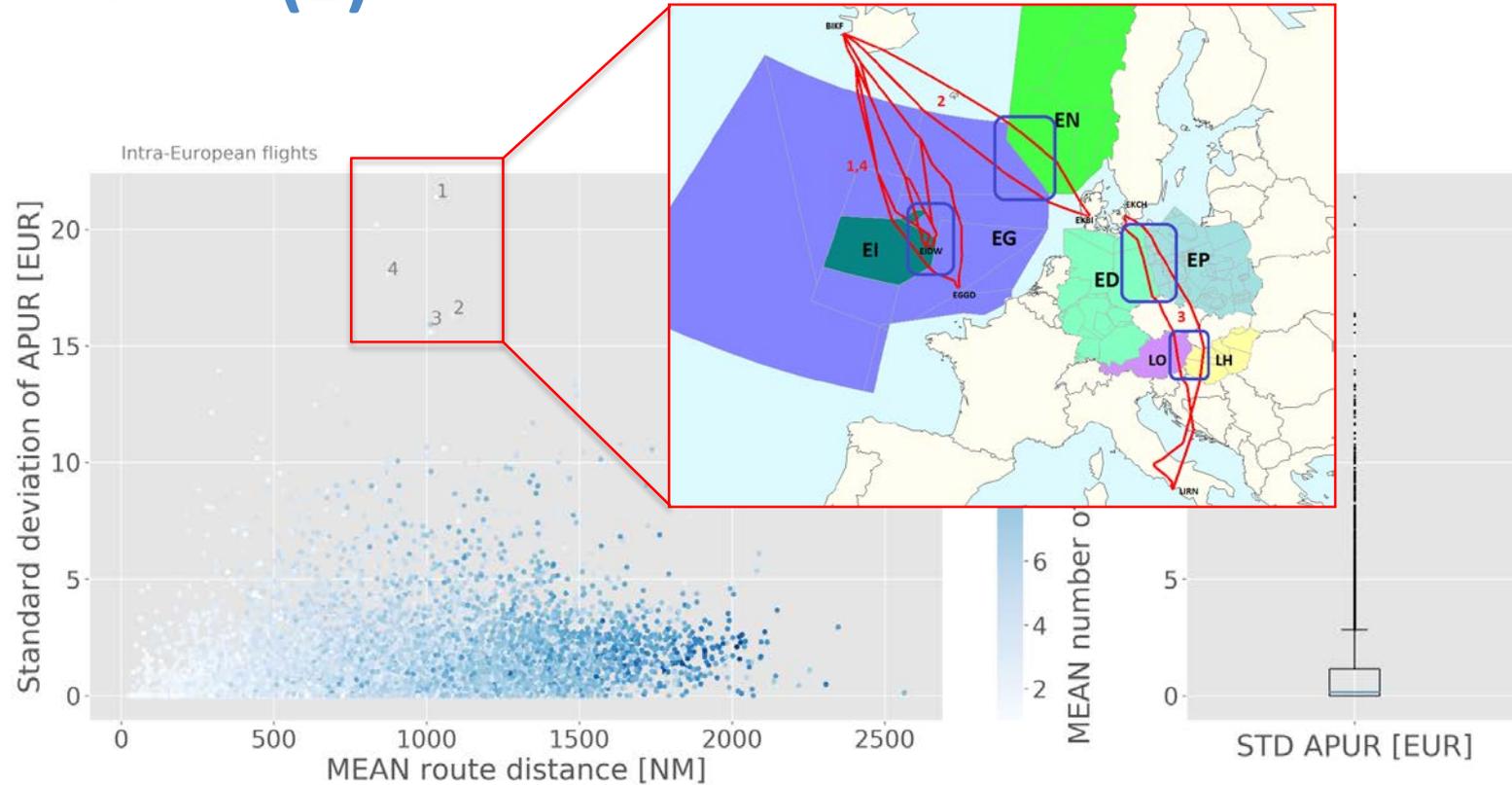
# Results (1)



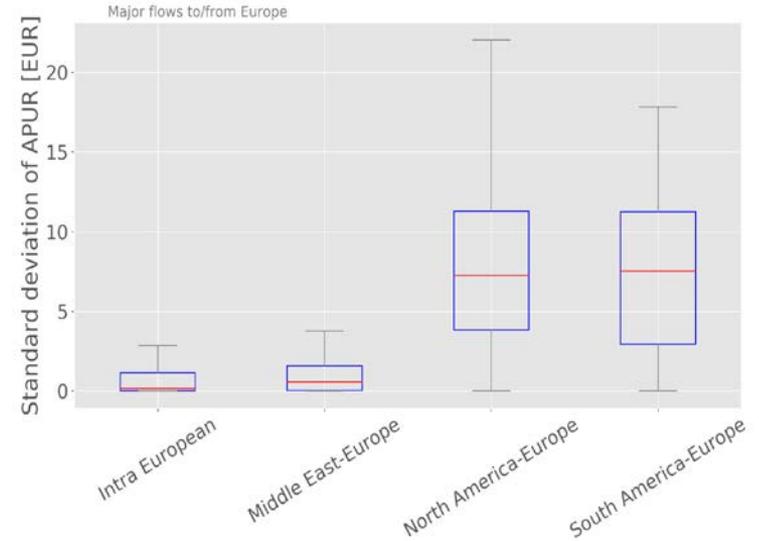
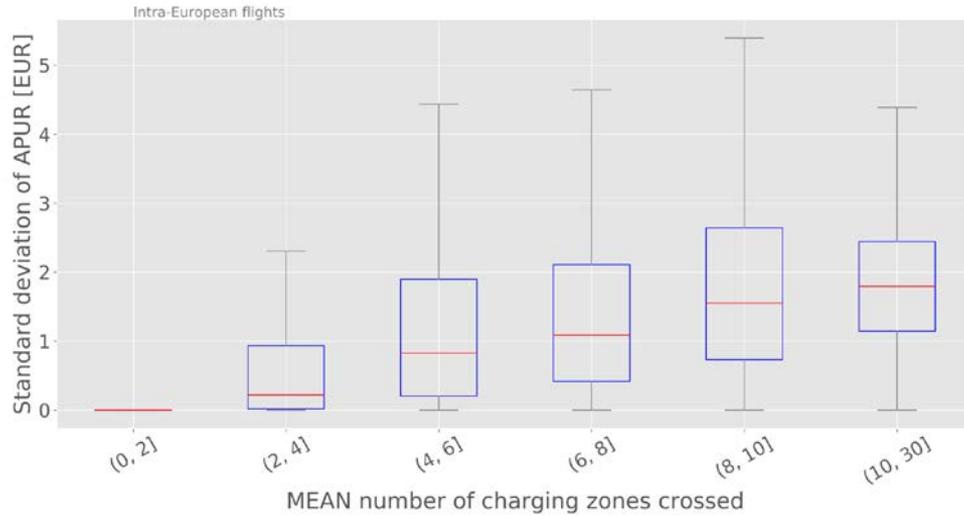
- Large portion of flights stay within 3 charging zones ( $\approx 62\%$ )
- Geographical differences in APUR reflect diverging costs of providing ATC services in different parts of Europe



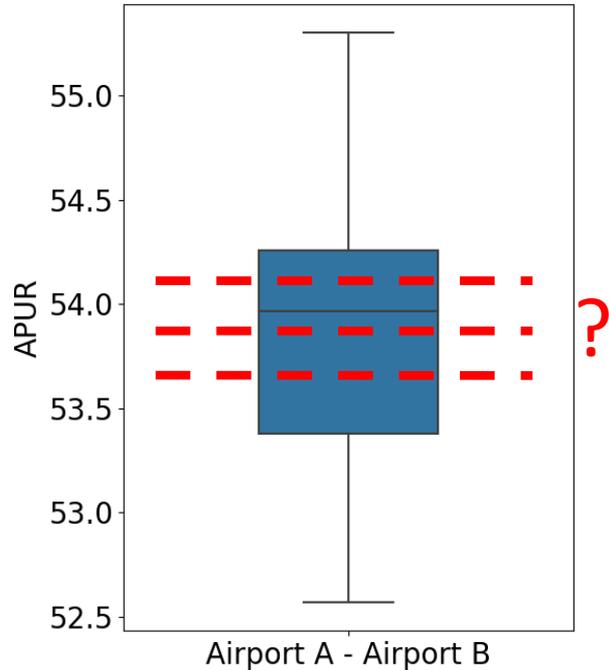
# Results (2)



# Results (3)



# Choosing reference APUR, further research



Can we estimate the traffic distribution over the charging zones for a given airport pair and thus choose APUR for the reference year?

Would this be facilitated in a potential scenario where Network Manager is granted more demand management instruments?



QUESTIONS?

[g.pavlovic@sf.bg.ac.rs](mailto:g.pavlovic@sf.bg.ac.rs)

---

Thank you very much  
for your attention!



founding members





# Wrap-up

Peter Hotham, Deputy Executive Director, SESAR Joint Undertaking

13 March 2019, World ATM Congress



founding members



EUROPEAN UNION



EUROCONTROL

# SESAR 2020 EXPLORATORY RESEARCH – GET INVOLVED!



## **Exploratory research call (ER-4 -€ 38+M)**

Not restricted to SESAR JU Members

Topics: ATM excellent science & outreach and ATM applications oriented research

*To be published soon on SESAR JU and EU H2020 portal:*

[www.sesarju.eu](http://www.sesarju.eu)

<https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/home>

## **Engage Knowledge Transfer Network**

Participate in workshops, thematic challenges and activities

<https://engagektn.com/>

## **Exploratory research call (ER-4 -€ 38+M)**

Not restricted to SESAR JU Members



INSERT TITLE

---

Thank you very much  
for your attention!



founding members



EUROPEAN UNION EUROCONTROL