



# Evolution of Automation, AI and ML research through the SESAR 2020 programme






## Engage – Thematic Challenge workshop on AI, ML and Automation

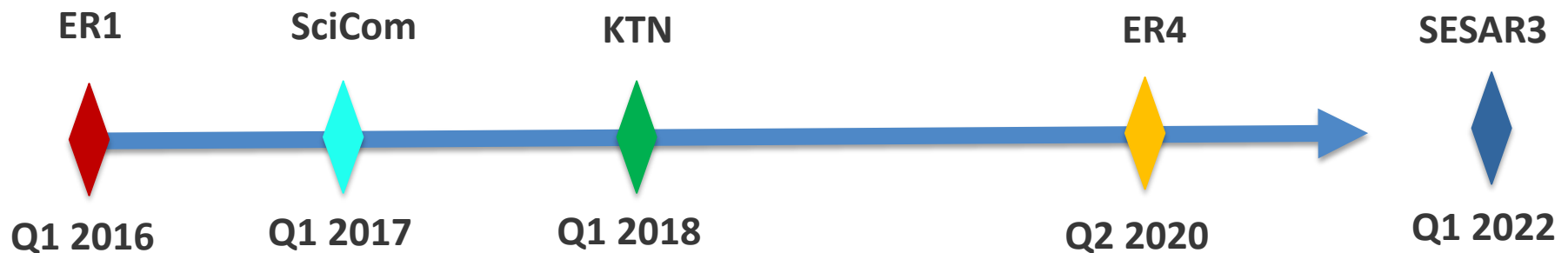
Luca Crecco (SJU) - 03 SEPT 2021

Founding Members



# Outline

- Automation, AI/ML in ER1 Call 
- The SJU Scientific Committee contribution 
- The Engage – Knowledge Transfer Network - contribution 
- Automation, AI/ML in ER4 Call 
- The Industrial Research (spanning throughout the S2020 programme)
- The future 



# Automation, AI/ML in ER1 Call

## 5.1.1.1. ER-01-2015 – Automation in ATM

Specific challenge: **Automation in ATM** hold the key to significant performance improvements across many aspects of ATM, which today relies on high levels of human intervention. Uptake of automation has been slow partly because the benefits of human cognitive abilities, especially in safety-critical situations, have provided strong arguments against change. The current spur of innovation in robotics and autonomy, within advanced industrial and service sectors, may extend more traditional notions of automation to potentially open up new fields of research. Since there is expected to be a significant increase in the numbers and types of aerial vehicles in operation, including remotely piloted vehicles, the scope for a new generation of autonomous automation solutions is significant.

The challenge is therefore to develop automation solutions that have the capability to provide substantial and verifiable performance benefits whilst fully addressing safety and security concerns. Research should fully take into account expected future technical and institutional developments together with forecast. In addition, the SESAR-sponsored HALA! Network<sup>26</sup> has been considering key issues of higher-levels of automation for ATM and its output should be considered as useful reference material

Scope: Proposals for research in this area should take an ambitious view of automation. Projects may look to build upon the existing legacy, or they could take a clean-sheet approach to design an ATM system that requires human intervention in a supervisory or control mode rather than in a direct operating mode. The latter ‘unconstrained’ line of attack should allow a bolder vision and open the door for new conceptual possibilities. Under this topic, there is substantial scope for learning from other transportation modes and other industries, particularly where robotics and autonomy are concerned.

[https://www.sesarju.eu/sites/default/files/documents/procurements/h2020-call-doc-er-sesar-ju\\_en.pdf](https://www.sesarju.eu/sites/default/files/documents/procurements/h2020-call-doc-er-sesar-ju_en.pdf)

## Just the flavour ....

**AGENT** – Adaptive self-governed aerial ecosystem by negotiated traffic aims to develop a framework proposing trajectory manoeuvres that take into account interdependencies between human behaviour, automation and aircraft performance.  
<https://www.sesarju.eu/projects/agent>

**AUTOPACE** - Facilitating the automation pace aims to research the skills and training strategies that will be necessary to address the challenges associated with automation and to enable controllers to do their job  
[www.sesarju.eu/projects/autopace](http://www.sesarju.eu/projects/autopace)

**MINIMA** – Mitigating negative impacts of monitoring high levels of automation aims to develop a vigilance and attention controller tool using electroencephalography, which can measure in real-time controller vigilance and triggers adaptive automation functionalities when vigilance is waning.  
<https://www.minima-project.eu/wp/>

**TaCo** – Taking control aims to develop a tool for guiding the controllers towards an optimised management of the movements of airport vehicles and aircraft: for example, it supports them in maximising the usage of the runway and minimising the global fuel consumption.

**STRESS** – Human performance neurometrics toolbox for highly automated systems design aims to examine the human performance issues, benefits and impacts of the shift towards increased automation.  
[www.stressproject.eu](http://www.stressproject.eu)

# Automation, AI/ML in ER1 Call



## Just the flavour ....

**BigData4ATM** – Passenger-centric big data sources for socio-economic and behavioural research in ATM

aims to investigate how new data sources coming from smart personal devices can be used to overcome the lack of information related to the difficulties to accurate, updated and reliable data on passenger needs and behavior.

[www.bigdata4atm.eu](http://www.bigdata4atm.eu)

**DART** - Data driven aircraft trajectory prediction research

aims to explore the potential of data-driven techniques for trajectory prediction, and agent-based modelling approaches for assessing the impact of traffic to individual trajectories

<http://dart-research.eu>

**MALORCA** – Machine learning of speech recognition models for controller assistance

aims to employ novel machine learning algorithms to obtain assistant based speech recognizer system

[www.malorca-project.de](http://www.malorca-project.de)

# The SJU Scientific Committee contribution



The SESAR 2020 Scientific Committee had the Automation Task Force working on:

- assessing the automation related research in SESAR1 and SESAR 2020;
- helping understand the role of automation, and the current research in this area, in other related fields of applications, such as transportation systems or aerial robots (drones).
- helping understand how advanced modes of automation, leveraging machine learning/artificial intelligence techniques, could be incorporated into heavily constrained, safety-oriented socio-technical systems such as ATM.
- helping elicit the role of automation and human operators in 2035+ scenarios in ATM.

The work of the TF was focused on the projection of current trends into the long term (2035+), and on the development of a long-term vision on automation and of an associated research roadmap. Three alternative long-term automation targets/scenarios were analysed, following a community-based process for the incorporation of different stakeholders' views, implemented through an ATM Automation workshop. These efforts are summarized in an **Automation discussion paper**, which concludes that for the mid to long-term future (2035/2050+) the most appropriate way to progress is to follow an evolutionary approach where a “Holistic Cognitive Support to ATM” vision is finally implemented. This vision remains resolutely human-centric, where human operators remain in control, being assisted by automated processes. However, it also advocates for the continuation of research in higher levels of automation, specifically in the area of U-Space.

<https://www.sesarju.eu/node/3649>

# The Engage – KTN contribution (1/2)



PhDs (total of 10)

## Just the flavour ....

### **Decision support system for airline operation control hub centre (DiSpAtCH)**

aims to investigate the use of artificial intelligence to support decision making in an airline operation control hub centre in highly complex scenarios, by detecting abnormal situations and dependencies in the diverse information flows.

<https://engagektn.com/>

### **Machine learning techniques for seamless traffic demand prediction**

Aims to investigate innovative approaches to air traffic demand forecasting based on the synergistic combination of physical models of aircraft trajectories with artificial intelligence and machine learning techniques

<https://engagektn.com/>

### **Machine learning applications to extend AGENT's conflict resolution capabilities**

building on AGENT's work, it aims to investigate possible improvements of several critical aspects of the system through applications of diverse machine learning techniques.

<https://engagektn.com/>

# The Engage – KTN contribution (2/2)

Engage catalyst fund projects (2 waves, total of 18)

## Just the flavour ....

### **Data-driven trajectory imitation with reinforcement learning**

Building on DART, it aims to generate algorithms for data-driven imitation of trajectories, following deep reinforcement learning techniques.

<https://engagektn.com/>

### **Machine learning techniques for seamless traffic demand prediction**

Aims to investigate innovative approaches to air traffic demand forecasting based on the synergistic combination of physical models of aircraft trajectories with artificial intelligence and machine learning techniques

<https://engagektn.com/>

### **Machine learning applications to extend AGENT's conflict resolution capabilities**

building on AGENT's work, it aims to investigate possible improvements of several critical aspects of the system through applications of diverse machine learning techniques.

<https://engagektn.com/>



# Automation, AI/ML in ER4 Call



## 2.1.1 SESAR-ER4-01-2019: Digitalisation and Automation Principles for ATM

### Specific challenge:

Increasing the Automation in ATM is considered as a key to significantly improve ATM performance. However, ATM is a continuous 24-7 set of services where the complexity of the ATM system, its fallback modes and necessary recovery steps has proved to be a major challenge for the introduction of further automation, and this has consequently slowed down the advancement of automation in ATM, especially in the most congested areas of Europe. The latest progress in the domain of Artificial intelligence and in particular Machine Learning may open new possibilities for further automation in ATM in high-density operations and some new applications have already been developed in SESAR (e.g. [7]). The application of Machine Learning for Automation in ATM also comes with new challenges,

One challenge of increasing automation is related to transparency of the automated system. Any automated assistance system needs to be able to provide the human operator with all information necessary to enable an understanding of the reasons for its behaviour and/or decisions. Otherwise the system may not be accepted or trusted by the operator, thus negating the theoretical benefits of the automation.

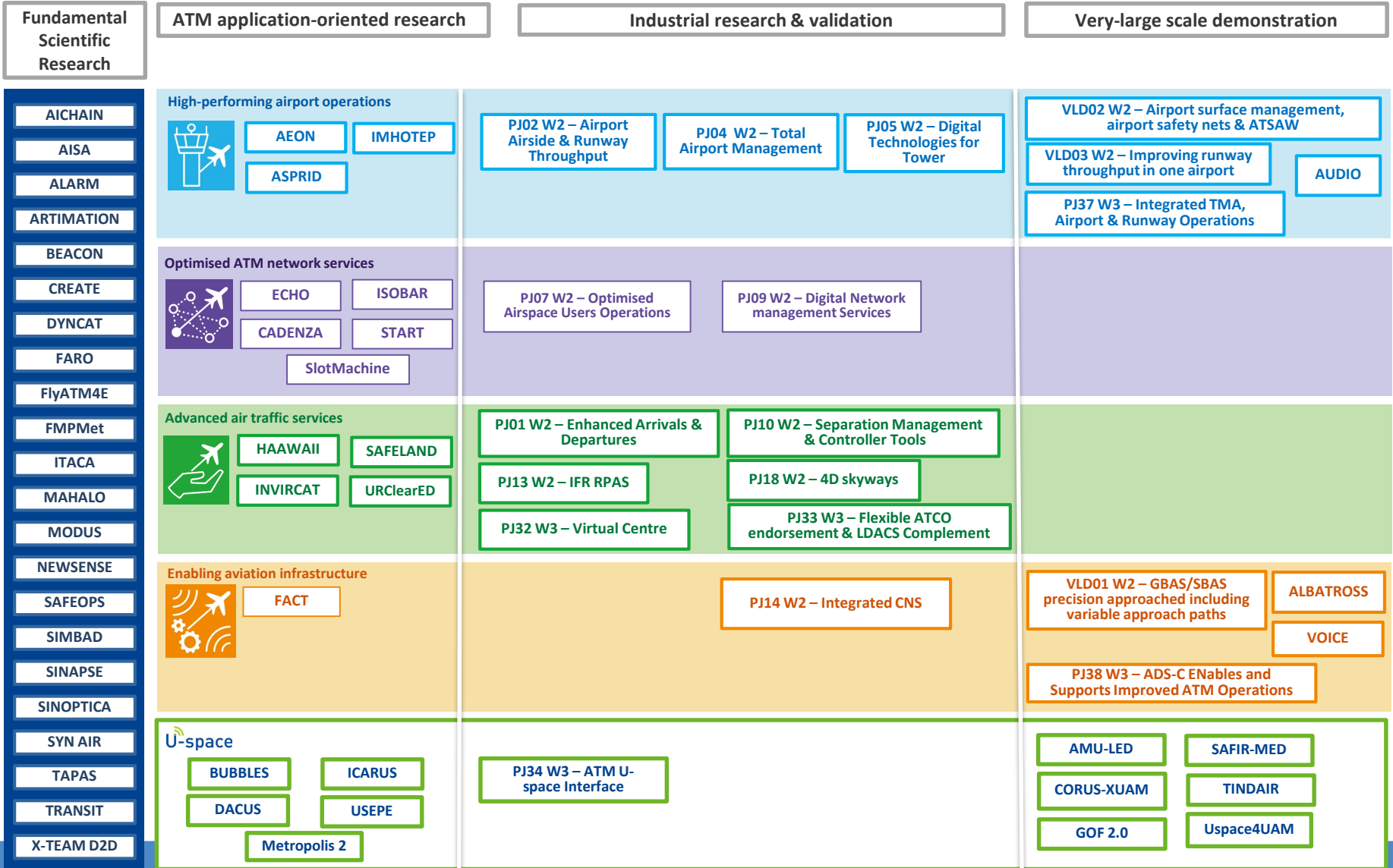
Another challenge is the Generalization of results from Machine Learning methods. Differences between the data used for training and the data feed to a trained algorithm can lead to unexpected results, including that not all situations can be anticipated during the training. Additionally, due to this

<https://www.sesarju.eu/news/new-call-launched-sesar-exploratory-research>

# SESAR 2020 – Projects overview as of March '21



NOSTROMO



# SESAR 2020 – Automation, AI/ML related projects



NOSTROMO

Fundamental  
Scientific  
Research

ATM application-oriented research

Industrial research & validation

Very-large scale demonstration

AICHAIN

AISA

ARTIMATION

FARO

MAHALO

SAFEOPS

SIMBAD

SINAPSE

TAPAS

High-performing airport operations



AEON

PJ04 W2 – Total  
Airport Management

PJ05 W2 – Digital  
Technologies for  
Tower

Optimised ATM network services



Advanced air traffic services



HAAWAI

PJ01 W2 – Enhanced Arrivals &  
Departures

PJ10 W2 – Separation Management  
& Controller Tools

PJ18 W2 – 4D skyways

Enabling aviation infrastructure



U-space

BUBBLES

USEPE

# The Industrial Research

Based on the well-known and established pipeline process according to which ER solutions proven to have reached a certain level of maturity are injected in the main industrial research, together with topics and research streams identified with the Programme members, some ER solutions have already been moved to IR (e.g. MALORCA, R-WAKE) and others are in the pipeline.

<a href="#"><u>PJ.01-W2-08A2</u></a>	<a href="#"><u>Automatic Controlled Time of Arrival (CTA) for management of arrival in en-route and on the ground</u></a>
<a href="#"><u>PJ.04-W2-29.1</u></a>	<a href="#"><u>Airside/landside performance management</u></a>
<a href="#"><u>PJ.05-W2-97.2</u></a>	<a href="#"><u>Automatic Speech Recognition at the TWR CWP supported by AI and Machine Learning</u></a>
<a href="#"><u>PJ.10-W2-96 ASR</u></a>	<a href="#"><u>Automatic Speech Recognition</u></a>
<a href="#"><u>PJ.18-W2-53A</u></a>	<a href="#"><u>Improved Ground Trajectory Predictions (TP) enabling future automation tools.V2 Stream.</u></a>
<a href="#"><u>PJ.18-W2-53B</u></a>	<a href="#"><u>Improved Ground Trajectory Predictions (TP) enabling future automation tools.V3 Stream.</u></a>
<a href="#"><u>PJ.18-W2-57</u></a>	<a href="#"><u>RBT revision supported by datalink and increased automation</u></a>

... and more

# Future of automation, AI & ML in ATM research



## This is what we want to discuss with you today!

The SESAR programme is expected to launch new Calls dealing with these topics, in alignment with the content of the Strategic Research and Innovation Agenda (SRIA)

<https://www.sesarju.eu/sria>

The SRIA details the research and innovation roadmaps to achieve the Digital European Sky, matching the ambitions of the '*European Green Deal*' and the '*Europe fit for the digital age*' initiative.

It contains several flagships (i.e. research areas) paving the way for aviation to become more scalable, economically sustainable, environmentally efficient and predictable. Some examples of flagships are:

- Connected and Automated ATM
- Air-Ground integration and autonomy
- AI for aviation

**Wishing you fruitful discussions, enjoy the workshop.**



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# Thank you for your attention!



Founding Members



The opinions expressed herein reflect the author's view only.

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