



FROM INNOVATION TO SOLUTION

SESAR magazine

Editorial



SESAR's exploratory research in the limelight



Florian Guillermet,
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“*There is a common consensus in the Air Traffic Management (ATM) community today that exploratory research, which prompts new thinking and unconventional ideas, is essential for the performance of the future European ATM system. It is therefore vital for the SESAR Joint Undertaking (SJU) to source, apply and build on knowledge that is produced outside of the SESAR Research and Innovation (R&I) Programme's applied research activities.*

Recognising this need, the SJU has dedicated resources to combining existing and developing new scientific research relevant to the field of aviation since the start of the SESAR R&I Programme in 2007. This edition of the SESAR magazine both considers the work that has been achieved over the last

few years, as well as giving readers an insight into the research challenges facing all of us in the coming years.

First off, the magazine examines the policy considerations of integrating exploratory research into the SESAR R&I Programme in an interview with two leading European officials: Maurizio Castelletti, Head of Unit, Single European Sky, Directorate General for Transport (DG MOVE) and Keir Fitch, Head of Research and Innovative Transport Systems (DG MOVE). I am delighted to see the European Commission's support for our long-term research endeavours and the interview clearly highlights the advantages of such research in ATM – providing a strong pool of scientific expertise and results whilst also providing academia with a tangible focus for their research efforts.

In a special feature in this edition, we get an in-depth overview of the research results already captured, and we take a closer look at some of the successful research projects and networks already set up. Thanks to the hard work and dedication of those taking part in the exploratory research projects and networks, exciting ideas and knowledge are converging to enable their introduction into the rest of the Programme, thus realising the innovation pipeline that we have aimed to establish.

Enjoy the read! 

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Florian Guillermet, Executive Director,
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Exploratory research: A catalyst for excellence in ATM R&I in Europe



The launch of SESAR 2020 Programme in 2015 will see the budget for exploratory research almost quadruple to 85 million EUR. In this interview, Maurizio Castelletti, Head of the Single European Sky Unit in the European Commission's Directorate General for Transport (DG MOVE) and Keir Fitch, Head of Research and Innovative Transport Systems (DG MOVE), explain what this budget increase will mean for the EU policy framework, ATM exploratory research and how they see research results feeding back to achieve the ATM of the future.

Why do you think it is important to dedicate more resources to ATM exploratory research?

Prior to the creation of the SJU and its Research and Innovation (R&I) Programme, support to ATM research, including exploratory research, was part of the EU's Framework Programmes (FP). Notably, significant resources were mobilised for such purposes during FP6 (2002-2006).

“SESAR has allowed ATM research to be progressively planned and implemented to reach higher levels of readiness, enabling its results (SESAR solutions) to be rapidly brought to deployment within the European ATM network in order to contribute to the achievement of the performance objectives of the Single European Sky (SES) policy.”



From left to right:
Keir Fitch, Head of Research and Innovative Transport Systems (DG MOVE), **Maurizio Castelletti**, Head of the Single European Sky Unit in the European Commission's Directorate General for Transport (DG MOVE)

The launch of SESAR marked a break with tradition - SESAR has allowed ATM research to be progressively planned and implemented to reach higher levels of readiness, enabling its results (SESAR solutions) to be rapidly brought to deployment within the European ATM network in order to contribute to the achievement of the performance objectives of the Single European Sky (SES) policy.

In this context, just over 23 million EUR (circa 1% of the total SESAR R&I Programme budget) has been allocated to exploratory research out of the 2.1 billion EUR budget managed by the SJU for the period from 2007 up to 2013, an amount that was then considered as the strict minimum by the ATM community.

Today progress in SESAR is tangible with a number of solutions ready for deployment. Whereas the phase concerning industrial research continues to develop towards completing the agreed roadmap (European ATM Master Plan), it is evident that in certain areas a more extensive fundamental research effort is

still required, calling for additional resources to be committed for exploratory research in the next funding period (2014-2020).

The SESAR R&I Programme for 2020 (SESAR 2020) is now part of Horizon 2020, the new EU R&D Programme, which sets the scene for a European transport system that is resource-efficient, climate-and environmentally-friendly, safe and seamless for the benefit of all citizens, the economy and society. Its air transport component is fully aligned with the long-term vision of Flightpath 2050. The latter includes but also goes beyond the scope of the European ATM Master Plan, requiring the development of more advanced system solutions, notably in the context of multi-modal transportation.

EU Member States have repeatedly declared that the implementation of the European ATM Master Plan is a must for Europe. However, it is essential to complement such targets and deliver the longer term ATM perspective embodied in Flightpath 2050. This brings up entirely new questions on the need for additional exploratory research activities, for which the Strategic Research and Innovation Agenda from the Advisory Council for Aviation Research and Innovation in Europe (ACARE) would be the baseline target, complementing SES in the longer term.

To respond to these needs, the SESAR budget for exploratory research has almost quadrupled from 23 million EUR in the original SESAR R&I Programme to 85 million EUR in SESAR 2020 - a budget closer to the one available under previous EU Framework Programmes. Furthermore, the leverage of this budget towards ensuring higher returns is also expected, given the tighter integration and complementarity now ensured between exploratory research and industrial research within the context of the SES policy, this being coordinated for the EU under the full responsibility of the SJU.

What are the benefits of creating a stronger link between exploratory and industrial research?

In aviation research, the industrial and service sectors tend to focus on delivering rapid economic benefits in the short to medium term. Reconciling this approach with the long term is a major challenge, given the level of uncertainty when it comes to return on investment and a lack of guaranteed outcomes, as well as the

“The SESAR budget for exploratory research has almost quadrupled from 23 million EUR in the original SESAR R&I Programme to 85 million EUR in SESAR 2020.”

potential emergence of unforeseen barriers, which can fundamentally call into question conceptual and operational approaches and planning. Exploratory research has to be given the mandate to push beyond today's thinking and thus also be given the "freedom to sometimes fail".

Past experience with SESAR industrial research has demonstrated that there is a need to strengthen interdependence between short to medium-term and longer term research activities, with the latter being pivotal to raising the ambition level through deepening advanced technological and operational concepts or solutions to be then further developed in industrial research. Exploratory research actions can provide the SJU's industrial partners with a pool of scientific expertise allowing them to think out-of-the-box and to take on risky ventures – notably those that have the potential of prompting disruptive step-changes and thus bringing valuable returns in the longer term.

This strong linkage between exploratory research and industrial research is deemed crucial for a successful delivery of SESAR and is indeed the justification for placing exploratory research under the aegis of the SJU. Nevertheless it will be essential for the latter to ensure the right balance in the management of exploratory research activities that also respond to industrial research needs, while also guaranteeing an appropriate innovative and independent thrust towards shaping the ATM of the future.

How do you see the results of exploratory research feeding back into the ATM of the future and the EU policy framework?

ATM exploratory research is at heart a tool to support innovation with manifold purposes: From shaping the ATM of the future through to supporting the development of an underpinning EU policy framework

capable of pushing it into the marketplace, in a holistic perspective that encompasses an integrated, multi-modal system of transportation. Indeed, exploratory research can help:

- ❖ Accelerate the fulfilment of the SESAR project, current and future SES objectives by providing more efficient, cost-effective and faster pathways to develop and deploy innovative solutions. This may include, for example, exploring the potential of the transfer of technology and other best practices from other industrial and service sectors into ATM. Such moves could create new economies of scale that in turn could improve the economic vitality of ATM services and help to remove more swiftly development and operational barriers that hamper progress, by adopting non-conventional techniques and solutions;
- ❖ Tailor advanced ATM-based solutions to inspire developments in other sectors, notably, in terms of traffic management of other transport modes – such as rail and maritime; and
- ❖ Support the evolution of the relevant EU policy and regulatory frameworks, notably the extension and refinement of the European ATM Master Plan for the period 2030-2050 to cover all aspects of the air transport chain. Novel aspects could be considered such as the impact of other EU regulations on the ATM of the future – including, for example, the airport balanced approach or the consideration of prospective evolutions of the whole of the transportation system, be it in vehicles, infrastructures, services or societal aspects.

The budget provided is through the EU's Horizon 2020 Programme. What does this mean for those who wish to apply for funding?

While the calls will be published and managed by the SJU, they will adhere to the overriding participation rules and regulations put in place by H2020. These rules guarantee transparency and openness in view of the broader participation from all stakeholders active in the ATM community.

How far should long-term research look ahead and what do you consider is the correct balance between responding to long-term ambitions and resolving today's problems?

Exploratory research has indeed a dual purpose. First,

it complements, where required, the on-going SESAR industrial research, which is geared to address first the challenges confronting European ATM in the short to medium timeframe. Second, it is instrumental in preparing for future solutions. Regarding the latter, it is essential that the prospective timeframe selected for ATM exploratory research is consistent with that of similar studies that will address the whole of the air transport system. Henceforth, 2050 would be a realistic reference as this is the timeframe adopted in the Flightpath 2050 vision, with an interim target set for around 2035.

How do you see SESAR 2020 contributing to the education of the ATM researchers and professionals of tomorrow?

Aviation is a dynamic and high-tech sector, which is critically dependent on a well-trained and motivated workforce. This requires top level education and training that are both fit-for-purpose and adaptable to ever-changing operational and technological contexts.

The new ATM solutions that are being brought about by SESAR are part of this evolution, requiring the appropriate expertise to operate, maintain and further develop new facilities. The strong links being established in SESAR 2020 between exploratory research and industrial research will eventually enable two kinds of pay-off in this context:

- ❖ ATM researchers and professionals will benefit from spin-offs of concept testing, validation and demonstration activities carried out by the industrial activities as a means to heighten their knowledge and expertise and perfect their training practices and tools;
- ❖ The air transport sector will have access to the full potential of Europe's scientific community to better prepare future generations of the European ATM workforce for mastering change and new challenges to come.

The SJU provides the perfect environment for such a purpose: a win-win situation, which will provide industry with a fantastic pool of expertise whilst providing academia with a tangible focus for their research efforts. The SESAR Innovation Days and the SESAR Young Scientist Award have already been successful initiatives. SESAR 2020 will further advance this industry-academia twinning process.

Focus on (A)



Pushing the boundaries of ATM knowledge

As a global leader in ATM research and innovation, the SESAR R&I Programme seeks to push the boundaries of our knowledge and understanding of what is possible in the future ATM system. The Programme's exploratory research activities are at the heart of this endeavour, the results from which will bring benefits to industrial research activities, as well as leading to the creation of a strong body of knowledge that will serve the ATM community beyond the lifetime of the Programme.

Exploratory research takes place today within Work Package E and is known by the acronym "WP-E" within the Programme. WP-E is an interdisciplinary work package, which aims to address long-term ATM R&I challenges. This approach enables researchers to develop ideas, concepts and technologies to concept and Technology Readiness Levels (TRL) 1 and TRL 2, thereby introducing knowledge from other non-ATM disciplines (e.g. complexity science, physics, economics, etc.) and applying it to the ATM domain.

WP-E aims to stimulate scientific research into ATM through the funding of both research projects and research networks. A total of 40 projects have received funding from by WP-E under two calls – A **first call resulted in 18 projects running from 2010**

“The results of these projects will feed into the future SESAR 2020 exploratory research activities, thus sustaining and further driving the development of innovative and unconventional ideas, and contributing to the successful evolution of the European ATM system.”



to 2013, while a **second call led to the selection of 22 projects**, the results of which are expected by the end of 2015. Both calls were **funded with a budget of approximately 23 million EUR**. The results of these projects will feed into the future SESAR 2020 exploratory research activities, thus sustaining and further driving the development of innovative and unconventional ideas, and contributing to the successful evolution of the European ATM system.

In addition to these projects, three research networks were created, covering automation, complexity science and legal challenges in ATM. The networks actively coordinate the research activities through managing PhD research activities, conferences, summer university courses, workshops and writing position papers based on the state-of-the art information available from all research sources, including the range of WP-E projects.

Addressing long-term ATM research challenges

WP-E aims to address common ATM research challenges related to proving the feasibility of fully automating parts of the ATM system; demonstrating



Theme 2: Towards higher levels of automation in ATM

The main aim of **Multidimensional Framework of Advanced SESAR Automation (MUFASA)** was to examine the impact that conformance to automated resolution advisories has on user acceptance and trust. MUFASA established that there is indeed a benefit in conformance, an important finding for the introduction of higher levels of automation. An extension of the MUFASA project will address the potential of automation transparency to benefit trust and acceptance, as well as controller decision consistency and “automation bias”. Meanwhile, results from the **System Performance under Automation Degradation (SPAD)** project indicated that the integration of the Functional Resonance Analysis Method (FRAM) in the federation of models is not fully mature to be used yet in predictive modelling in ATM.

the feasibility of introducing complex-systems methods to ATM; defining suitable performance metrics for ATM from a complex-system theory point of view; the ATM design of the future; the prospect of an open-source ATM; assessing performance benefits and the application of economic incentives.

While projects are still ongoing from the second call, the majority of projects from the first call have now been finalised. The following section provides some examples of the WP-E project results realised so far:

Theme 1: Legal aspects of the paradigm shift

The **Addressing the Liability Impact of Automated Systems (ALIAS)** project developed a Legal Case methodology, which identifies the legal aspects that should be taken into consideration at various stages of the design, development and deployment of the new technologies in highly automated scenarios. ALIAS also organises an annual conference and has set up an online legal research network in order for experts to share digital material addressing themes of liability attribution in automated contexts in ATM. In 2014, ALIAS II was launched with the aim of taking the Legal Case concept further by applying and consolidating it in order to provide the ATM community with a self-standing legal case methodology to test its application in the areas of ACAS X and RPAS.

ATM needs to answer questions such as how to safely and legally automate with the human still in the loop, while still maintaining a safe fall-back and recovery mechanism, or whether certain tasks should only be automated with adequate provision for automation robustness and resilience to cope at all times – thus the human role would discharge certain responsibilities fully to the automated systems.

Theme 3: Mastering complex systems safely

The **Complex Adaptive Systems for Optimization of Performance in ATM (CASSIOPEIA)** project proved the benefits of applying complexity science to ATM and studied three selected case studies:

- ❖ Case study 1 investigated the consequences of imposing night curfews on major European airports. Results indicated that this has very little positive impact on local air quality and noise, and could even potentially have severe negative economic consequences for airlines, airports, regions and countries.
- ❖ Case study 2 addressed the impact of slot trading between airlines in terms of increased costs and delays. The results captured suggest that cost savings of up to 30% can be achieved when authorising airlines trade slots, without influencing network performance and overall delays.

- Case study 3 studied the use of a dynamic costs index and hence the impact that different approaches to punctuality could have on airline costs. A strategy to reduce delays of up to 10 minutes was found to lead to significant costs savings, when compared to the approach widely used by airlines of attempting to eliminate all delays.

The **Emerging network-wide effects of inventive operational approaches in ATM (NEWO)** project analysed the effects of new prioritisation criteria on network performance, such as on-time performance and delays. The results confirm that the First-Come-First-Served (FCFS) concept performs better than most other prioritisation criteria at a global network level. The conditions for which the Most-Capable-Best-Served concept has the potential to outperform FCFS will be studied in a refined setting, which includes higher global equipage levels and a refined segmentation of the results.

It is the particular focus of SESAR and WP-E to establish a managed high performing network level of operations that take account of complex interactions and uncertainties. Research is needed to steer the development of algorithms and techniques that allow for optimising such networks at a global scale and establishing robust problem-solving in real-time situations.

and that reactionary (knock-on) delays in the network account for almost half of all delays in Europe. These effects have been better characterised by the POEM analyses. Future research will continue to address the relationships and trade-offs between passenger-centric and flight-centric metrics, as well as investigate the feasibility of considering targets for passenger-centric metrics in future SES reference periods and in the SESAR R&I Programme. Future research could also be linked to investigating additional elements, such as other performance metrics (e.g. delay targets), new rules (e.g. User-Driven Prioritisation Process (UDPP), future traffic levels, aircraft sizes, frequencies and wave structures, the impact of new policies / EU regulation, and the performance of a given airline or specific network routes.

The sample of WP-E projects described above illustrate the diversity and richness of not only the themes addressed by WP-E, but also the interesting results that are emerging across a number of domains, such as automation in ATM, mastering complex systems safely, legal aspects, and economics and performance. These results will be fed back into the SESAR R&I Programme on a continuous basis. Going forward, exploratory research will remain a top priority for SESAR 2020, ensuring that high quality scientific knowledge is captured and built upon in order to achieve a high performing and connected aviation system in Europe.

Theme 4: Economics and performance

The **Passenger-Oriented Enhanced Metrics (POEM)** project has built a European network simulation model with explicit passenger itineraries and delay cost estimations. POEM concluded that simple flight prioritisation rules, based on passenger numbers, are ineffective. In addition, project results showed that policy-driven rules only make an impact when current airline constraints are relaxed and that airline cost minimisation rules can result in win-win outcomes. Furthermore, the project concluded that passenger-centric metrics are needed to see the full impact of operational change





Exploratory research projects seek to find answers to complex questions

SESAR's exploratory research projects are multi-partner undertakings, which aim to examine and move innovative ideas along the innovation pipeline into industrial research. This section of the SESAR magazine focuses on two successful, ongoing SESAR R&I projects: MUFASA and NEWO.

Would controllers better accept automation that thinks like they do?

The Multidimensional Framework for Advanced SESAR Automation (MUFASA)* project started from a simple, but provocative question: Would controllers accept automation that appears to think and solve problems in exactly the same way that they do?

Few would disagree that the future ATM system will require more (and more sophisticated) automation. Automation will be asked not only to perform routine controller "housekeeping" tasks but, increasingly, it will potentially need to oversee aspects of the controller's more strategic and cognitive tasks, such as conflict detection and resolution. However, evidence from ATM operational and research communities, suggests that limited controller acceptance can jeopardise ATM automation developments. The notion is that differences in the cognitive styles used by either humans or machines can create a mismatch that threatens acceptance and, ultimately, the trust and use of sophisticated decision aiding automation. There have been various attempts in the past to develop automation, which is consistent with humans' strategic style, but these attempts have generally been hindered in one important regard: they have tried (usually with limited success) to actually build such a system before evaluating it.

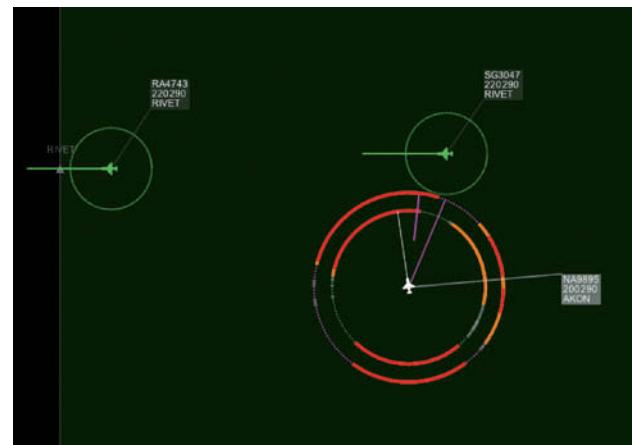


Figure 1: Simulation display, showing the Solution Space Diagram (SSD) for aircraft NA9895 that is used to resolve a pending separation conflict with aircraft SG3047.

Against this background, the MUFASA project was set up in order to separate and quantify the tendency for controller bias towards automation. That is, if one could build automation that appeared to perfectly match the strategies of the human, would the human readily accept and trust its advice? To answer this question, the team simulated advanced decision aiding automation by capturing and replaying for controllers the unrecognisable recordings of simulation sessions, including air traffic and controller inputs. A total of 16 en-route controllers were replayed a number of recordings, half of which were derived from their very own previous performance (and which by definition fit their own strategy), and half of which were derived from a colleague (who had chosen a different – but work-

* The initial MUFASA project was a SESAR WP-E funded collaboration between Lockheed Martin UK IS&S, the Technical University of Delft (TUD), the Center for Human Performance Research (CHPR), and the Irish Aviation Authority (IAA).

able solution). Controllers, in real time, had to either accept or reject each proposed solution. The team then evaluated whether factors such as acceptance rate, workload, and response time were influenced by whether “automation” had matched controllers’ own strategy.

Results demonstrated that controllers were both faster to respond to and more accepting of proposed solutions when these matched their own previous performance. The team also uncovered one unexpected and noteworthy result: in nearly 25% of the cases, controllers actually disagreed/rejected their very own previous solution, when they believed this came from automation.

How can it be that controllers, in effect, disagreed with themselves nearly one quarter of the time?

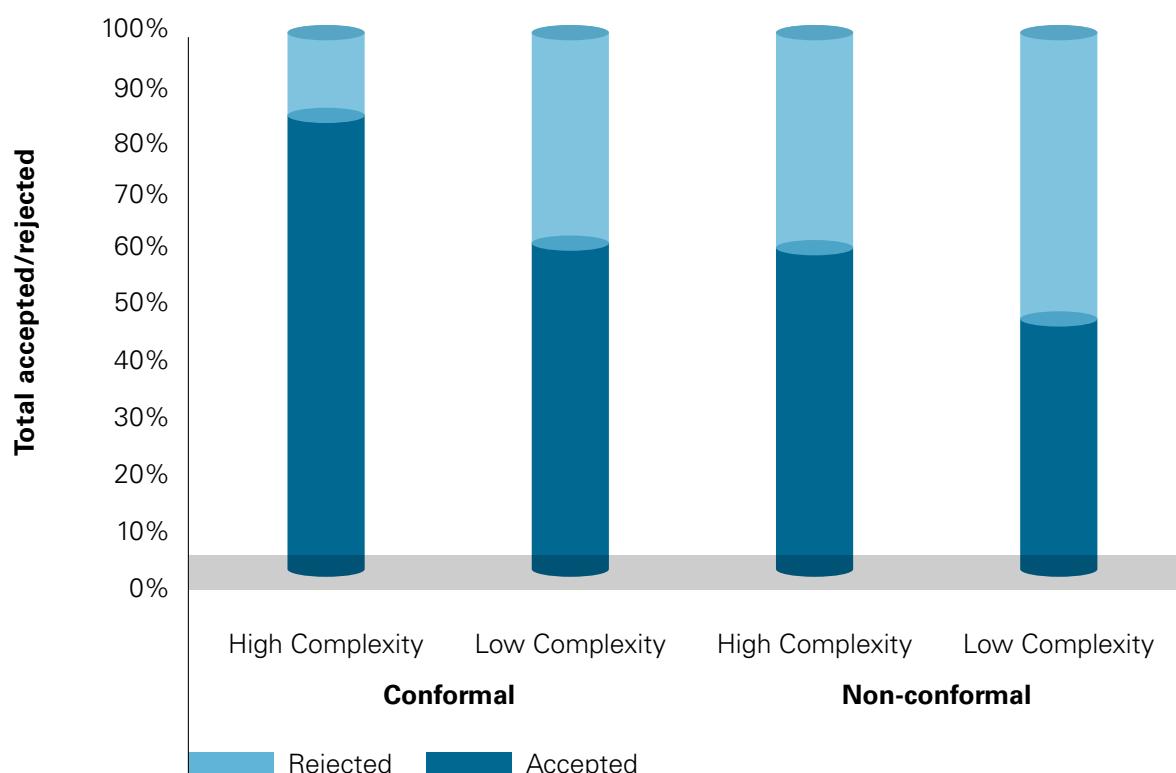
The MUFASA team has been exploring this and other related issues in trying to answer the following questions:

❖ Are controllers, as some have suggested, inconsistent in the strategies they bring from moment to moment, or from one situation to the next?

❖ And do these results speak not to an automation bias per se, but to an advice bias – that is, would controllers have been as unaccepting of such advice if they had believed that the advice had come from a colleague, as opposed to an automated system?

The results of MUFASA, and spinoff research, underscore the important role that strategic conformance can play in both controllers’ willingness to embrace new decision aiding automation, and in how we design and implement such automation. The lessons from MUFASA are not limited to ATM, of course, and apply to any number of other domains in which automation is being designed to assist the human decision-making process.

Figure 2: Acceptance rate, as a function of traffic complexity and strategic conformance





NEWO: Investigating effects of new prioritisation criteria on network performance

The Emerging network-wide effects of inventive operational approaches in ATM (NEWO) project aims to investigate the effects of new airport departure prioritisation criteria on network performance. In this interview, NEWO Project members talk about their unique project, its results and how these results can serve future ATM research and development, and, more broadly, aviation.

What is innovative about the NEWO project?

There are many network behaviours in air transport that cannot be understood from a local perspective, such as propagation phenomena, geographical stability and global performance degradation. NEWO uses complexity science and examines other complex networks in order to understand some of the still blurry aspects of the air transport network behaviour.

In the case of NEWO, the innovation came from the direct application of concepts and metrics defined in the complexity science field and from the innovative thinking of ATM experts inspired by a new formulation of old problems.

Our project performed an outlook to gather prioritization strategies already applied in other sectors such as logistics, electricity and adapted them to the specific scenario of departure flights within the European air transport network.

The NEWO team used modelling and simulation techniques to analyse a multi-component systems with complex interactions as in the case of the connectivity of the flights within the European network. The tool used, ATM-NEMMO, exploits a mesoscopic approach

Figure 3: Flight milestones and phases implemented in ATM NEMMO

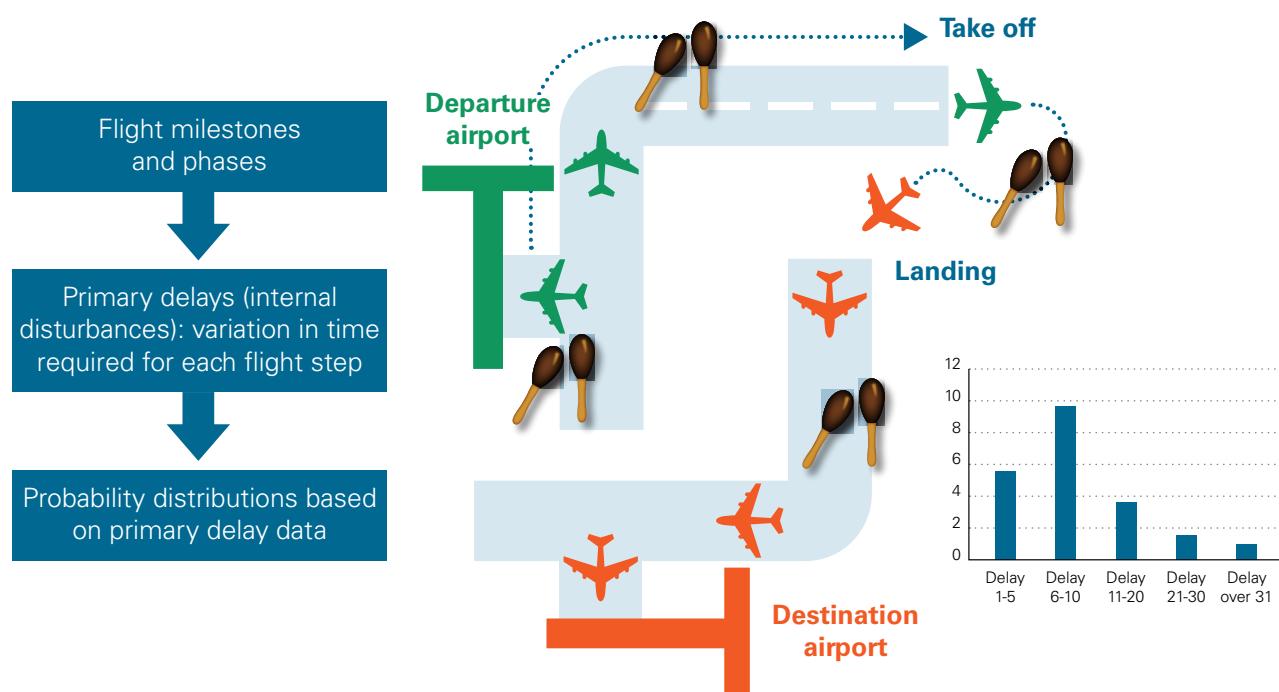
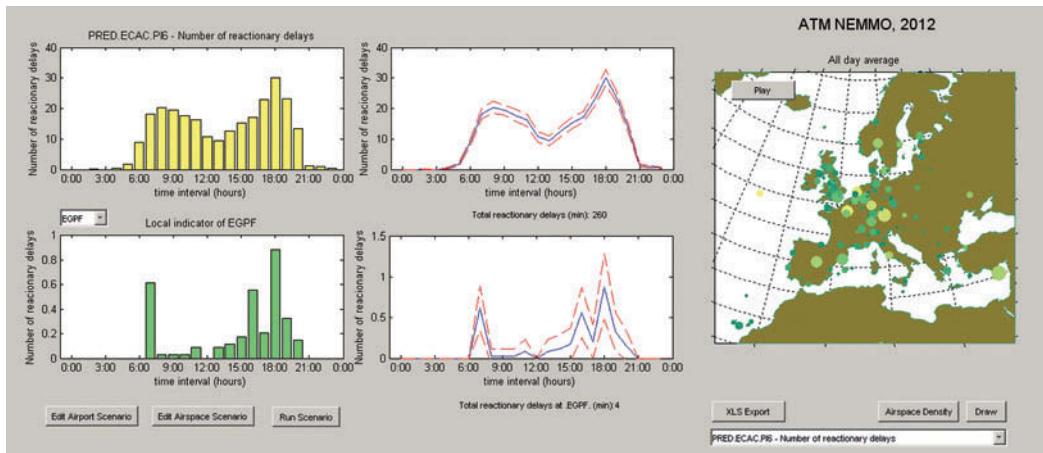


Figure 4: ATM NEMMO Interface



where probabilistic methods account for microscopic details of the air transport network without losing the macroscopic and strategic view of the system.

What have the project results revealed about prioritisation criteria?

This research has resulted in a catalogue of solutions and has produced simulation empirical evidence of their suitability for tackling the management of capacity shortfall scenarios in the framework of complex air transport networks.

But all that glitters is not gold. Initially, promising approaches have shown to deliver fewer benefits than those expected as compared to existing strategies such as First-Come-First Served.

The results have provided a good basis with which to further study the impact of operational changes in the network in terms of:

- ❖ Expanding the analysis of how giving priority to airline interests can provide a better “network picture”;
- ❖ Exploring the application of different prioritisation criteria in defined areas of the network and during specific time periods;
- ❖ Deepening the analysis of the network response, mainly in terms of robustness and resilience, to different congestion scenarios, and;
- ❖ Including new operational approaches and prioritisation strategies that have not yet been analysed.

How do you believe the results of NEWO can serve future ATM research and development, and, more broadly aviation?

The behaviour of a congested air traffic network is still an open issue within the field of ATM. In highly congested networks, sub-optimal behaviours may emerge, such as bunching, deadlocks, delays, or too long recovery times, which may spread across the network and hinder its performance.

So far the ATM community has made use of models and computer-based tools for different purposes (analysis, research, operational support, validation) covering a wide range of issues and metrics related to different Key Performance Areas (KPAs).

The state-of-the-art modelling and simulation technique in this project has enlarged the scope of air transport modelling with a new mesoscopic approach. The model has built a framework allowing for the analysis of macroscopic behaviour of multi-component systems with complex interactions, as it is the case for the air transport network. This is an important achievement in air traffic modelling terms, which in the past was focussed on local and uncoupled network models, rather than on global models capable of capturing non-linear coupling effects.

Applying complexity science to a network of airports has helped in the understanding of how the rules governing the interactions between various elements give rise to emergent behaviours across the whole network.

SESAR in depth (A)



Pooling ideas and expertise through research networks

Research networks are important components of the exploratory research work of the SESAR R&I Programme. Research networks provide a structured way to build research knowledge, competence and capability that can serve industry in the long term. Each network comprises partners from academia, research centres, industry that share a common expertise or interest in a relevant ATM or transport domain. The following section of the SESAR magazine focuses on SESAR's three research networks: ALIAS, ComplexWorld and HALA!

Legal experts address the relationship between automation and liability



Alias

Is it possible to develop a structured, or case-based, methodology to help assess the legal implications of higher levels of automation in ATM? Are current liability regimes at national and international levels suited to accommodate the introduction of new technologies? These are the questions posed by legal experts who are taking part in Addressing the Liability Impact of Automated Systems (ALIAS).

With partners from across Europe, the ALIAS project and network explores the relationship between automation and liability, focusing on ATM and aviation but with the potential to consider and learn from other domains such as healthcare, and oil and gas industries. In addition, the role of ALIAS is to research liability attribution as an emerging fundamental issue of human-

technology interaction, to be taken into account in highly automated environments.

ALIAS was originally launched in 2011 as a research project and up until 2013, the project consortium worked on developing a Legal Case methodology, which identifies the legal aspects that should be taken into consideration at various stages of the design, development and deployment of the new technologies in highly automated scenarios.

The resulting Legal Case can be applied to any ATM concept involving automation. In this context, automation is not limited to "full automation", where an entire task is completely delegated to a machine, but rather covers cases where humans and machines interact, with machines supporting the human operator. The Legal Case can produce different kinds of results, such as recommendations to inform the design or legal design measures, recommendations for undergoing acceptability assessment by stakeholders, and recommendations for when residual or operational liabilities exist in a new automation configuration.

The screenshot shows the ALIAS network website interface. At the top, there's a header with the ALIAS logo, a search bar, and a 'Search' button. Below the header, there's a 'Network statistics' section with two charts: 'Alias Network accesses' (bar chart) and 'Alias network, affiliations and affiliations category' (pie chart). On the left, there's a sidebar with links for 'Resources' (Scribd, flickr, YouTube, twittter), 'Network statistics', and 'Related contents' (Images, Documents, Slides, Videos). The main content area displays a list of topics with their respective statistics (Views, Answers, Votes). Topics include 'The MH17 accident' (78 views, 12 answers, 2 votes) and 'UAS/RPMS Regulation over Europe' (113 views, 9 answers, 0 votes). Each topic has a 'Read more...' link and an 'Add your comment...' button.

In 2012, ALIAS set up a legal research network as an online community and library for sharing a repository of a wide set digital materials which address the themes of liability attribution in automated contexts in ATM. In addition, the network organises an annual conference bringing the virtual community face-to-face. At present the community welcomes more than 160 experts coming from several fields of study, such as technical, operational, research, legal and institutional domains.

In 2014, ALIAS II was launched with the aim of taking the Legal Case concept further by applying and consolidating it in order to provide the ATM community with a self-standing Legal Case methodology. In particular two test applications are foreseen, aiming to respectively address Airborne Collision Avoidance System (ACAS X) and Remotely Piloted Aircraft Systems (RPAS). Furthermore, ALIAS II continues to develop the virtual community for research experts and expand it towards projects that deal with topics linked to liability attribution and legal issues.

Today the network brings together more than 180 members, which is constantly growing. If you feel you could either contribute or benefit from joining

Category	Count
1. REFERENCE MATERIAL ON CASE-BASED APPROACH	~ 5
2. OUTCOMES OF THE ALIAS PROJECT	~ 102
3. LEGAL ANALYSIS	~ 74
4. INTERNATIONAL AND EUROPEAN LAW	~ 53
5. ACCIDENTS IN AVIATION	~ 35
6. REFERENCE MATERIAL ON HUMAN FACTORS AND AUTOMATION	~ 25
7. NEW AUTOMATED TECHNOLOGIES FOR AVIATION	~ 19
8. OTHER LIBRARIES	~ 6
9. USEFUL LINKS	~ 21

this unique research network then contact info@aliasnetwork.eu or visit: www.aliasnetwork.eu today!

SESAR in depth (B)

Mastering Complex Systems Safely!



ComplexWorld was established in order to explore how complexity science could contribute to understanding, modelling and ultimately driving and optimising the behaviour and evolution of the overall ATM system. Due to the nature of the air transport system, which involves a very large number of agents interacting non-linearly, emergent behaviours arise that typically cannot be modelled and analysed using traditional techniques. Accordingly, the ComplexWorld network promotes an innovative approach to ATM research through the application of state-of-the-art complex systems' science methodologies to ATM. This approach provides insights into the understanding of these phenomena; it also helps to overcome the limitations of current methodologies in ATM research and finds its basis in domains such as particle physics and biology.

Coordinated by the Innaxis Research Institute, the ComplexWorld network has the following European partners: the University of Seville, the University of Westminster, the German Institute of Flight Guidance (DLR), the National Aerospace Laboratory of the Netherlands (NLR) and the University of Palermo. The network has an open approach to participation, welcoming a wide range of entities from universities and research centres, to industry stakeholders and SMEs. Today more than 100 entities have registered in the network and share ComplexWorld's objectives:

- ❖ Fostering the interaction and cross-fertilisation between the air transport and complex systems' research communities, as well as attracting talented researchers from the complex systems' field into ATM research;
- ❖ Defining and detailing the main research challenges and potential benefits for the ATM system, in order to map out and build momentum for the future direction of research in the field;

- Identifying state-of-the-art developments in relevant periphery disciplines;
 - Defining, developing and maintaining a clear roadmap for establishing a research community at the crossroads of complexity science and ATM that provides added value to the European ATM sector.

In addition, ComplexWorld provides a common framework for different SESAR activities that are thematically linked to complexity management in ATM, including SESAR exploratory research projects and PhDs in which the network can act as a catalyst.

To achieve these challenging objectives, ComplexWorld has organised a variety of activities, ranging from actions to enable the emergence of innovative research approaches, to promotional and communication campaigns to strengthen and broaden the network of experts involved, to finally disseminating results of complexity science applied to ATM research. By enabling a suitable balance between scientific R&I and networking tasks, ComplexWorld has succeeded in creating a flow of knowledge that enhances the cohesion within the research community and

enables scientific content to evolve quantitatively and qualitatively.

The ComplexWorld network has published a position paper which has now evolved into a WIKI to widen the knowledge developed within the network to a broader audience, especially to contributors around the complexity management field. The ComplexWorld network is organised around five sound research themes:

1. Uncertainty
2. Emergent behaviour
3. Data Science
4. Non-classical, complex performance metrics
5. Resilience

Each of the above areas are presented through three relevant research lines, defined through a problem statement, a literature review, and particular research challenges to be tackled.

Outreach and engagement are important elements of the network's activities, which, since its establishment, has organised a significant number of events, including:



- ❖ The first ComplexWorld Conference at which the network launched its activities;
- ❖ Three tutorial sessions with 16 speakers from research areas such as stationarity, uncertainty, delay propagation, robustness, complex performance metrics, intermodal complexity and weather forecasting;
- ❖ Four workshops aimed at synchronising the results achieved by SESAR exploratory research initiatives that are working on topics related to ComplexWorld, such as resilience, uncertainty, network modelling and metrics;
- ❖ Two workshops on data science in aviation workshops, to create awareness on this promising and challenging topic of extracting knowledge from aviation data. Both editions were deemed successful in terms of speakers, audience participation and resulting outcomes;
- ❖ Three seminars were organised in parallel with larger events, such as ATOS 2012, ISIATM 2013 and ICRAT 2014;

❖ The ECCS (European Conference on Complex Systems) satellite events that strengthened relations within the complex systems' community and opened the network up to new stakeholders from outside the aeronautical sector.

To further its outreach, the network is working on the preparation of a book "Complexity Science in Air Traffic Management," to be published in 2015. The publication will be a key outcome of the network, since it will contain the most relevant research results achieved during the network's lifetime.

During 2015, the network will also organise a second ComplexWorld Conference, in which all relevant entities in the domain of complexity in ATM research will be invited to present their results and future visions of research. This format will enable the network to summarise and consolidate recently completed long-term and innovative research. The conference will also help to shape the future of complexity research in the field in the years to come by identifying challenges and opportunities, thereby bringing significant added value to ATM research.

<http://complexworld.eu/wiki/Main>
www.datascienceworkshop.com

SESAR in depth (C)



Say HALA! to enhanced ATM performance through automation



HALA!
SESAR
RESEARCH
NETWORK

In order to meet the increasing safety, cost-effectiveness and other performance targets, higher levels of automation will be required in the future ATM system. Established in 2010, the Higher Automation Levels in ATM (HALA!) research network promotes long-term research in ATM automation by exploring new ideas

and concepts in automation, and their application within ATM.

In HALA! automation is understood as a "tool used to improve ATM-related processes through the use of technology". This simple enough definition hides a very complex area, which requires the best minds in research to provide fresh thinking to ensure that the strengths of automation are maximised while its weaknesses are minimised.

The network offers a perfect platform to coordinate research activities and foster innovation on automation

in ATM. By removing many of the constraints found within industrial research, the network allows a more flexible environment in which ideas on ATM can flow. In many ways, HALA! can be considered an observatory in which to research state-of-the-art concepts and challenges associated with automation in ATM. To date, key achievements include research into predictors for improving trajectories, close to real-time interactive trajectories optimisation, resilience analysis under ATM system degradation, traffic synchronisation. This is valuable research which seems all the greater considering the limited resources available for long-term research efforts.

HALA! is a true research partnership, bringing together organisations with knowledge of all the areas related to automation in ATM. A total of 10 European universities; 3 research centres, and 4 aeronautical companies (e.g. Airbus) are taking part in the projects, offering excellent opportunities for a cross-fertilisation of ideas between academia and industry. The relationships that

have been developed between academies, research institutions and aeronautical companies have prompted the setting up of several ambitious long to medium-term research projects, such as STREAM, MUFASA, UTOPIA, and SPAD.

The network also focuses on encouraging young researchers into the ATM field, which is proving an effective way to supply industry with fresh minds capable of novel thinking. In addition to traditional university guidance, PhD researchers are mentored by organisations that represent the ATM industry so that the research knowledge developed can be transferred into industry. The network also hosts several dedicated workshops, seminars and a week-long summer school in order to encourage learning in automation in ATM.

The HALA! network is confident that the efforts of their collaboration will help speed up the application of new operational procedures and supporting technologies that will increase the performance of the overall ATM system.



HALA! SESAR Research Network Towards Higher Levels of Automation in ATM

www.hala-sesar.net

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