[EN-114] INTRODUCTION TO THE SESAR WP-E RESEARCH NETWORK: HALA! (HIGHER AUTOMATION LEVELS IN ATM)

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Abstract: HALA! (Higher Automation Levels in Automation) is a SESAR WP-E Research Network inspired and underpinned by the highest principles of collaboration, transparency and innovation for the effective application of automation of the ATM processes. HALA! is ready to support and complement SESAR R&D activities in Automation, providing a Scientific Collaborative Platform through the participation by the most relevant world class universities, R&D centers and industry in ATM.

Keywords: automation, long-term research, network

1. PROLOGUE

In the last years our knowledge has rapidly increased allowing us to focus our research resources to very specific areas. As a consequence we know far more about specifics and less about everything. Good examples of this trend are the Navigation and Airspace Management domains. Future ATM tools and technology may provide the users with all the required information about any flight at any moment, but how do we turn all that information into knowledge? How do we achieve it in an effective way? Automation of this process will be a major goal impacting on all research fields. An effective management of our knowledge is actually a basic requirement to go on developing but …can the knowledge really be automated? And is it worth it?

In HALA! We believe that effective automation can create a step change and thereby enabling us to achieve even more ambitious goals beyond those encapsulated by SESAR.

HALA! (Higher Automation Levels in Automation) is a Research Network which was initiated in September 2010, inspired and underpinned by effective collaboration, innovation, transparency, flexibility and efficiency as required to successfully deliver the objectives of SESAR WP-E. The main human resource is knowledge and its efficient use lies on automation.

HALA! means in Spanish "Go on! Get moving!"

2. INTRODUCTION

In order to bring the expected benefits and to ensure that there are no delays in the implementation of SESAR (Single European Sky ATM Research), research resources need to be applied to the exploration of novel, unconventional and high risk areas, involving new technologies, concepts or ideas. However, the need to deliver a system on-time and on-budget, constrains the possibility of the SESAR projects to invest in high-risk, novel or unconventional areas. The SESAR WP-E Research Networks will foster the application of existing methodologies and techniques in new ways, potentially applying scientific disciplines that have not previously been brought to bear in air traffic domains. HALA! will provide a flexible environment in which ideas on Automation in Air Traffic Management (ATM) will flow using a common approach and removing most of the constraints on the research carried out in SESAR.

The organizations participating in HALA! cover all the knowledge areas related to automation and their experts collaborate actively with SESAR. As Innovation is a main objective of HALA!, Doctoral (PhD) level research, involving the participation of leading universities in collaboration with each other, and the ATM industry, are the heart of HALA! In addition to the traditional university supervision, PhD researchers are guided by organizations that represent the ATM industry in order that the knowledge that is developed can be most

efficiently translated into effective tools. Finally the HALA! participants have a long proven experience on collaborating in complex projects and provide HALA! with the necessary skills and experience to achieve the challenge of automation.
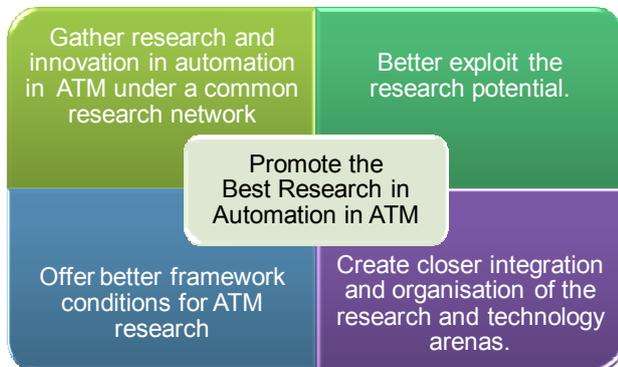
Figure 1. HALA! Organizations Distribution

3. SESAR AUTOMATION STRATEGY

The SESAR capacity and safety objectives are to be achieved by a significant enhancement of integrated automation support with the Human operators remaining at the core of the system. To ensure overall performance of the net-centric and information-shared ATM network, the following widely recognized high-level automation principles will guide the development:

- Automate only to improve overall system and human performance, and not just because the technology is available;

- The overall impact of automation and allocation of functions shall be systematically determined before implementation, to avoid unintended results such as additional complexity, loss of appropriate situational awareness, too high or too low workload or potential for error;

- A balance shall be obtained between the efficiency created by automation and the need for the human to be able to recover from non-nominal and/or degraded mode of operations (automation failure strategy);

- Place the human in command. The human shall be the automation manager and not the automation monitor, i.e. automation shall assist humans to carry out their tasks safely, efficiently and effectively;

- Automation should be error resistant and error tolerant;

- Involve users from the system design phase to ensure improvement of overall system performance and to foster trust and confidence by the human in the automation.

- Maximize overall system performance through increasing the utility of tools while mitigating human errors..

HALA! has adopted these principles and will push them forward to ensure both coherence with the SESAR programme, and at the same time favor innovation.

4. WP-E: THE NEED FOR INNOVATIVE AND LONG-TERM RESEARCH

The scope of Workpackage E may broadly be stated as "covering ATM / CNS and related aeronautics research activities not currently addressed by the other work packages of the SESAR work programme" (WP-E Thematic Programme).

Although the SESAR ATM Master Plan itself "constitutes the basis for establishing the SESAR Joint Undertaking's work programme and the development phase of the SESAR project" (EC COM(2008) 750); its coverage is not exhaustive. It has been broadly recognized that more R&D effort is required to prove that all aspects of the Target Concept can deliver the expected benefits and resolve the identified open items. There are issues requiring research and innovation which are not currently covered by the programmed SESAR activities. In particular there is a need and also an opportunity for complementary innovative and long-term research.

This additional research will include research into concepts for implementation beyond the nominal SESAR timeframe of 2020 and also complementary research and beneficial innovation to the current SESAR working programme

- Long-term research needed for addressing applications to become operational beyond the current SESAR 2020 timeframe. In this respect work may build on the concept and may be somewhat more detached and futuristic.

- Innovation needed for identifying and investigating topics that might bring new approaches and solutions, or needed to identify and propose research activities not currently planned within the 'mainstream' SESAR development work packages.

In particular HALA! Research Network will explore unconventional and traditional ATM areas alike, involving new technologies and concepts around the theme "Towards higher levels of automation".

5. THE RESEARCH THEMES

SESAR is a global (end-to-end) project involving the whole air transport system. Navigation, ATM and airports will work as part of the same network towards the future. SESAR materializes the needed increases in capacity and

the development of innovative techniques and technologies involving most relevant scientific fields. To achieve these goals four thematic research areas have been defined to provide focus to research in WP-E:

1. Towards Higher Levels of Automation in ATM; (HALA!)

2. Mastering Complex Systems Safely;

3. Economics and Performance.

4. Legal Aspects of Paradigm Shift;

Research Networks will gradually be set up around each of the four research areas; the first two Research Networks have recently been established

- HALA! covering 'Towards higher levels of automation in ATM' and

- ComplexWorld focusing on 'Mastering complex systems safely

A call for network proposals concerning the theme 'Economic and Performance' is open at the time of writing this article.

5.1 Toward higher levels of automation

This research theme covers legal issues that may accompany paradigm shift in the future ATM context. This includes aspects such as certification, liability, competition and intellectual property rights, at levels ranging from institutional down to detailed operations. Emphasis will be on the changes brought by future ATM paradigms, including the system as currently proposed by SESAR.

The ATM system has evolved at a remarkably slow pace and today is still based on paradigms and technology that have not fundamentally changed for decades. There are undoubtedly a number of valid reasons for this, but significant progress in ATM will not be possible without a much bolder vision that, in particular, allows significantly increased levels of automation.
The Research Network "Towards Higher Levels of Automation in ATM" is probably the network most connected to the other three research themes of the first call for WP-E Research Networks in the framework of the SESAR Work Programme.

Firstly, Automation is strongly related to complexity and safety. One of the objectives of process automation is to improve the safety of ATM operations. As the role of the human in ATM provides too many opportunities for error, process automation should be designed to decrease the risk of accidents caused by human error. However, recent incidents/accidents statistics have shown that while the effect of human error largely remained constant, new problems involving automation complexity are increasing. Furthermore, automation has very important legal implications, especially those derived from the new roles and responsibilities of pilots and ATCos in ATM imposed by higher levels of automation. In addition, automation is often based on new modes of sharing sensitive information, which must be protected. The need to protect sensitive data is an issue that cuts across all aspects of ATM's activities.

5.2 Mastering complex system safely

This research theme focuses on air traffic management as a system of systems, with the objective of characterizing the sources and consequences of its complexity and emergent properties, especially those related to safety. This will provide valuable insight into the system-wide impacts of change that are today not well mastered.

Using this new 'science', complex phenomena in the fields of economics, social sciences, and biology and communication technologies have been tackled successfully over the last decade or so. The complexity of the air traffic management system, and of the interactions of its subsystems, is undeniable, so the ambition of this theme is to explore the potential of applying these rapidly maturing mathematical analyses and modeling tools to the ATM domain.

5.3 Economic and performance

This research theme is concerned with long-term economic and performance issues associated with the ATM system as foreseen in the SESAR concept and beyond. It is expected both to apply traditional methods and to develop innovative approaches. In particular it will examine how economic factors and performance requirements drive new developments in the ATM system.

The evolution of the ATM system as foreseen in SESAR will lead to significant changes that will impact economic and performance issues. Studies by the PRU [PRU] and others have produced detailed work that provides significant insights into the true costs and performance of the current system. This theme seeks to build on this traditional analysis with new approaches that can influence the future.

The deficiencies and problems inherent in the complex world of ATM have been known for a long time and are well documented. The situation however is one in which change is slow and innovation limited. There is a need to investigate alternatives to the 'business as usual' and how to implement them considering economic and technological aspects of the system, as well as cost and benefit issues and the possibilities for new business models. Participants in this research theme are expected to stimulate debate and research proposals on alternative ways of meeting the longer term challenges.

5.4 Legal aspects of paradigm shift

This research theme covers legal issues that may accompany paradigm shift in the future ATM context. This includes aspects such as certification, liability, competition and intellectual property rights, at levels ranging from institutional down to detailed operations. Emphasis will be on the changes brought by future ATM paradigms, including the system as currently proposed by SESAR.

These networks are founded on the spirit of cooperation. Network research activities are designed to support SESAR on its development process. The complex and automated scenario designed by SESAR will require the knowledge and experience to link navigation with economic and legal fields. The four research networks are ready to provide expertise and specialized knowledge beyond 2020. Even though at this moment is difficult to establish formal connections with the other Research Networks, HALA! envisions full coordination with the other three Research Networks.

6. HALA! RESEARCH NETWORK

The SESAR Concept of Operations requires a paradigm shift from a fragmented system with only few strategic planning functions and heavily reliant on tactical controller intervention to an integrated one based on collaborative strategic management of Business/Mission Trajectories. In the future European ATM system to be brought about by SESAR, the Business/Mission trajectory becomes the centerpiece of a new set of operating procedures collectively referred to as Trajectory-Based Operations (TBO). While some of the enablers to implement TBO (e.g. better data sharing through SWIM, improved ground based trajectory prediction) seems to be feasible within the SESAR timeframe until 2020, further steps are desired to achieve the maximum benefit of trajectories close to the optimum as aspired by the airspace users and with regard to social needs (such as environmental sustainability). The HALA! Research Network aims to contribute to these activities by both discussing the current developments in the framework of SESAR in view of short- and medium-term recommendations for improvements as well as an "out of-the-box" thinking to add innovative ideas on a long-term basis.

Thereby is understood and also key aspect of the network activities that TBO promote the involvement of Flight Operations Centers (FOCs), ATM service providers and the aircraft in the management of air traffic through Collaborative Decision-Making (CDM) processes, in order to achieve a fair trade-off between the business preferences of the individual users and the constraints that need to be in force. The implementation of TBO will require the human actors in the ATM system to rely on advanced decision-support tools (DSTs) that will assist them in the execution of Trajectory Management (TM). TM is the process at the core of TBO by which the Business/Mission Trajectory of the aircraft is established, agreed, updated and revised through CDM processes involving aircraft operator, ATM service providers and Airports (where applicable), except in time-critical situations when only flight crew and controller are involved. HALA! will both envisage and discuss the innovative improvement of DST for the controllers as well as the aspect of full automation of parts of the ATM system (e.g. particular en-route sectors).

TM controls the adjustment of the Business/Mission Trajectories of individual aircraft within a flow to provide efficiency (in view of time and fuel costs for the airspace users as well as environmental sustainability), manage complexity and ensure adherence to safety criteria by resolving potential conflict situations. TM will be enabled by information exchange through SWIM (System-Wide Information Management) and will be implemented as a rolling process from the planning phase through to the execution phase. Major challenge in this context arises from the massive amount of data that has to be considered by an integrated optimization function consisting of the mentioned criteria and others. Automated systems may have to be developed in an incremental way. HALA! will contribute with innovative ideas to stepwise increase the number of optimizations criteria to be considered within the according automated processes without neglecting the principle of transparency and equity.

Those future DSTs tools that will participate in the TM activities must rely on Trajectory Predictors (TPs) that can generate reliable trajectories that fulfill the requirements of the specific client application they serve. In principle, different applications will demand different capabilities from their underlying TPs. Therefore, the future (fully) automated ATM system will require high levels of integration and synchronization among all the different TP users, which can range from sophisticated DSTs for arrival management, flight planning or conflict detection and resolution to Unmanned Aircraft Systems (UAS) for cargo applications. The seamless integration of the different ATM users and providers beyond SESAR deployment phase (2020) will require a deep understanding of the fundamentals of trajectory prediction and management (in particular the principles and cost functions of flight planning and execution), the design of sophisticated DSTs tools for future requirements, new users and for higher levels of automation, a paradigm shift in the approach to ATM

services and the development of new operational concepts and automations to accommodate new airspace users, such as UASs. HALA! will approach these challenges by the elaboration and discussion of sound methodologies in order to enable the assessment of SESAR developments with particular view onto the compliance with the set requirements of the different stakeholders in the ATM system.

7. RESEARCH TOPICS

The main research teams of HALA! will be described in-depth in the White Paper document of the Research Network. The following sections summarize the initial research areas of HALA!:

7.1 Objective 1: 4D trajectory Management
This objective consists of defining, prototyping and validating a common Trajectory Management and Prediction framework that covers the entire Business/Mission Trajectory lifecycle and takes into account all stakeholders involved (FOC, aircraft, ATM service providers, airports). This common Trajectory Management framework would need to be defined in close coordination with at least the SESAR Work Packages and should cover the transition path from the requirements imposed by SESAR to a full automated ATM system.

7.2 Objective 2: New Roles Assignment
Capacity increase required by future air transport needs can not only be provide by the reduction in controller work load. New roles for managing aircraft trajectories, separation provision and trajectory de-confliction needs to be articulated.

Identification and definition of new roles in the aircraft trajectories management is one of the clues for an efficient future ATM. Nevertheless, those new roles are today a matter of conceptual proposals.

7.3 Objective 3: Advances Decision Support Tools
This objective consists of defining, prototyping and validating advanced Decision Support Tools (DST) for airborne and ground systems that could support all the levels of automation envisaged in SESAR WP-E. These Advanced DSTs will need to rely in sophisticated trajectory-based applications that will make intensive use of the research done in Trajectory Prediction and Management within the Research Network

7.4 Objective 4: Network Centric ATM Services
This objective consists of defining, prototyping and validating a new operational concept in where different ATM services are centralized. This approach would permit a high level of maintainability and reliability of the different ATM services that the different ATM users would require. This operational concept will require the integration and intensive use of Advanced DSTs for the deployment of the appropriate ATM services.

7.5 Objective 5: UAS in Controlled Airspace
This objective consists of defining, prototyping and validating a futuristic operational concept that considers the integration of UAS in a managed airspace under TBO. Operating within such airspace will most likely imply certain surveillance, communications and trajectory synchronization requirements to be fulfilled by the aircraft (both manned and unmanned), as well as certain required ATC automation capabilities (for example, to conduct centralized de-confliction). The UASs would be equipped with simulated Sense and Avoid capabilities that may or may not be based on the surveillance and trajectory exchange mechanisms required for operating within TBO airspace. The research in this field will take in consideration the research done in Advanced DSTs and ATM services conducted before.

8. DESCRIPTION OF THE CO-COORDINATOR, MEMBERS AND PARTICIPANTS

HALA! Research Network is currently compound of thirteen Members[1] and near fifty Participants[2] spread over all Europe. In fact, HALA! Partners belong to seventeen different countries giving the Research Network total geographic coverage and wide Research and Development Capability. This way, most important Countries in the Automation, Communications and ATM/CNS fields are taking part in the Research Network.

HALA! is willing to accept new participants from all over the world, which can take full advantage of the benefits of the Research Network.

There are three different kinds of organizations:

- Universities: They are a key part of the Network, they will supply new PhD holders, and a variety and a wealth source of knowledge.

- R&D Centers: They will provide means to carry out the research activities as well as expertise in the several fields of study.

- Companies: They are the link with the industry and will provide information to the network about the real needs of the aeronautical community.

All of them are extremely important for getting a strong structure of the Network and crucial for boosting research

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[1] Members are defined as those legal entities who formally acceded to the Contract and have the responsibility to manage the Network

[2] Participants are interested entities willing to share their knowledge and expertise about the theme studied by the Research Network

activities and creating new knowledge in Automation Field. Figure 2 shows the proportion by type of the research Network. Nearly fifty percent of the partners are Universities giving the HALA! Research Network a high level of Research capability also holds by the R&D Centers (20%). The Majority of the Participants and Members are explicitly engaged to R&D (Universities and R&D Centers) but a thirty one percent of Companies give the consortium a complete representation of the European ATM Industry.
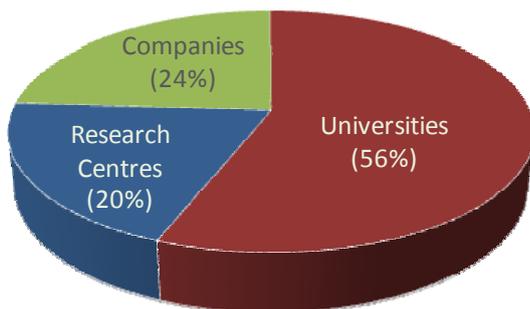

Figure 2. HALA! Organizations Distribution

Four of the Participants: Indra, Thales, Airbus and Honeywell are Members of SESAR JU giving the Research Network the necessary awareness of SESAR state and needs and enabling the coordination between SESAR and HALA! activities.

HALA! is coordinated by the Air Navigation Research and Development Group (GINA) of the Universidad Politécnica of Madrid (UPM).

GINA-UPM is backed by some of the best European Universities in ATM R&D: Imperial College London, KTH, TU Braunschweig and TU Dresden.

The group of members is completed by:

- Research centers: CRIDA, IRIT, NLR. Some of them are participated by universities (CRIDA by UPM) or collaborate with them (NLR collaborating with TU Delft),

- Aeronautical companies: Boeing R&TE, Deep Blue, EADS, and GMV SKY.

The result is a very competent team whose efforts are aimed towards the research activities in Automation and the collaboration with SESAR.

9. SCIENTIFIC COLLABORATIVE PLATFORM FOR KNOWLEDGE MANAGEMENT

Pollenizer is a communication platform that has been select to support the HALA! Research Network. It has been selected to achieve the previously defined objectives on the principles of transparency, collaboration and effective use of resources, to facilitate growing together towards a Higher Automation Level in ATM.

The Science Collaborative Platform provides an optimal flow and use of the information. The main goal is supporting the Automation Research Network with communication and collaborative as well as Data storage tools for the involved stakeholders (Members, Participants, EUROCONTROL and SESAR JU) in an orderly and accessible way.

The Platform enables Members, Participants, EUROCONTROL and SESAR JU to interact in a cyclic, collaborative process which will lead to the elaboration of knowledge for and from workshops, white papers and other activities performed within the Research Network. The outputs may become into inputs feeding again the platform by fostering new collaborative activities or creating new dissemination materials. This way, knowledge and expertise relevant to ATM Automation will be progressively built.

Scientific Collaborative Platform Process is shown in Figure 3. The figure presents the main actors involved in the process (Members, Participants, EUROCONTROL and SESAR JU); inputs and outputs; and three blocks representing the services provided by the platform Dissemination tools, Pollenizer Data and Collaborative tools.
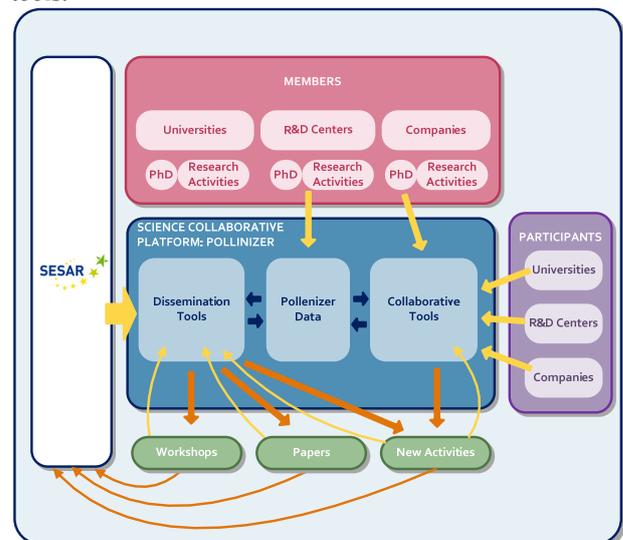

Figure 3 Scientific Collaborative Platform Process.

9.1 DISSEMINATION EVENTS
The main events of HALA! Network will be:

- Yearly conferences will complement the Pollenizer internet-based interaction through vital (i.e. more immediate and iterative hence much more effective) personal contacts and exchanges. The goals of yearly conferences are to disseminate information and experience on automation research in ATM processes, to contribute to education of a new generation of PhDs students and researchers in the field of

automation research and to future issues and strategies for SESAR and beyond SESAR. Apart from being a specific forum of HALA! members and participants, yearly conferences will also constitute a more general meeting place and discussion forum, open for guests from, outside the network as well.

The first HALA's conference will be held in Barcelona in May 2011.

- HALA! network will organize a yearly joint conference with all the networks of WP-E towards the end of the year in order to cross-fertilize the research by feedback from respective disciplines and explore overlapping areas. The goal of these joint conferences is to present the progress of each network. These events will also increase SESAR spirit of cooperation. In 2010 a joint workshop with ComplexWorld will be organized at the Innovative Research Workshop and Exhibition (INO) at the EUROCONTROL Experimental Centre.

The HALA! Network will also organize a 1-week Summer school orientated towards PhD candidates and researchers around a variety of automation topics ranging from the technical to the human as well as the integration between both and tailored towards the SESAR 2020 vision. The invitations will be sent to members, participants and the broader ATM/industrial/academic community.

The courses will be a unique opportunity to learn and share experiences and knowledge with experts of recognized prestige in their area of activity.

The first year these courses will be organized by the UPM as part of their summer courses that are held every July in La Granja de San Ildefonso (Segovia).

10. REFERENCES

[1] www.hala-sesar.net

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