HALA! (Higher Automation Levels in ATM)

Deliverable 10: 2nd Progress Report – PhD supervision

PhD student: Martina Ragosta

PhD supervisor: Prof. Philippe Palanque

Academic Year 2011/2012
# Table of content

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Introduction</td>
<td></td>
</tr>
<tr>
<td>2  Current progress on the PhD</td>
<td></td>
</tr>
<tr>
<td>2.1 Complying with regulations at Université Paul Sabatier – Toulouse III</td>
<td></td>
</tr>
<tr>
<td>2.2 Getting involved in the ATM domain</td>
<td></td>
</tr>
<tr>
<td>3  Activities during the first two years</td>
<td></td>
</tr>
<tr>
<td>3.1 Dissemination activities</td>
<td></td>
</tr>
<tr>
<td>3.2 Training Activities</td>
<td></td>
</tr>
<tr>
<td>3.2.1 Progress with respect to the research</td>
<td></td>
</tr>
<tr>
<td>3.2.2 State of the Art</td>
<td></td>
</tr>
<tr>
<td>3.2.3 Work on Processes, Method and Notations</td>
<td></td>
</tr>
<tr>
<td>3.2.4 Case studies</td>
<td></td>
</tr>
<tr>
<td>4  Scientific Production - Papers Publications of the First Two Years</td>
<td></td>
</tr>
<tr>
<td>5  Final Considerations and Evaluation</td>
<td></td>
</tr>
<tr>
<td>6  References</td>
<td></td>
</tr>
</tbody>
</table>
1 Introduction

This document describes the progresses that have been made during the first year of Martina Ragosta PhD. This PhD thesis is developed in collaboration with the Interactive Critical Systems (ICS) team of the IRIT lab in Toulouse and Deep Blue s.r.l. consulting & research in Roma. It is funded by HALA! SESAR Research Network (EUROCONTROL) and started early March 2011 under the joint supervision of Prof. Philippe Palanque and Alberto Pasquini.

This report covers the first twenty-four months of the PhD. During this period the student improved her knowledge about the topic of the PhD, both on automation aspects and on modelling of partly-autonomous computing systems. She also started to produce some contribution to her research domain, mainly at the process and methodological levels.

This deliverable is structured as follows. Next section is dedicated to the current progress of the PhD towards its completion and addresses in particular how it complies with the regulations of the Université Paul Sabatier – Toulouse III, and how knowledge about the ATM field has been gathered. Section 3 details the progresses made during the first two years covering successively dissemination activities, training activities, and progress on the PhD subject. Third section contains the list of publications that have been accepted during this first year. Last section provides an evaluation of the student as well as the progress she made and projects this first two years into the tasks to be accomplished in the last year.

2 Current progress on the PhD

2.1 Complying with regulations at Université Paul Sabatier – Toulouse III

As part of the PhD programme it is mandatory to attend courses offered by the University (either at the master level or at the doctoral one). Martina already started to attend several courses especially in the area of interactive systems engineering and human computer interaction. A complete list of these is provided in the paragraph 3.2. Training Activities.

In order to be allowed to defend a PhD it is mandatory to have publications accepted in 2 international conferences. A selected list of publications is provided in the paragraph 4. Scientific Production - Papers Publications of the First Two Year.
2.2 Getting involved in the ATM domain

As for acquiring knowledge in the ATM domain, Martina followed some courses and carried out several activities. Beyond that, she has been involved in user studies carried out by Deepblue involving real time simulation of AMAN system. During the second year of the PhD Martina spend about 2 weeks at DeepBlue to perform data analysis of the real-time simulation of an AMAN system that was performed at the end of the first year.

3 Activities during the first two years

This section presents the activities carried out during the first two years of the PhD at the level of dissemination of research results (to conferences and workshops), participation in training programs (both courses summer schools, involvement in Real – Time Simulations (RTS)) and in the progress towards the research objectives of the PhD.

Figure 1 presents in a diagrammatic way the progress that has been done during the first year of the PhD.

![Figure 1: Timeline of the PhD showing activities during the first two years](image)

3.1 Dissemination activities

Here is the list of accepted publications related to the work that has been carried during the first year.


The First SESAR Innovation Days (http://www.sesarinnovationdays.eu/) hosted by Ecole Nationale de l'Aviation Civile (ENAC), Toulouse, France from 29th November to the 1st December 2011. She presented a poster in the dedicated session and was also a co-author of the paper entitled “System Performances under Automation Degradation (SPAD)”. The other co-authors were Erik Hollnagel, Célia Martinie, Philippe Palanque, Alberto Pasquini, Eric Rigaud and Sara Silvagni.

CHI 2012 workshop: End-user interactions with intelligent and autonomous systems (http://chi2012.acm.org/cfp-workshops.shtml) that will be placed in Austin, Texas from the 05th to 12th of May 2012. With Célia Martinie and Philippe Palanque she is a co-author of the paper entitled “Some Issues with Interaction Design and Implementation in the Context of Autonomous Interactive Critical Systems”.

ATACCS 2012: 2nd International Conference on Application and Theory of Automation in Command and Control Systems that will take place at Imperial College of London U.K. from 29th to 31st of May. She is a co-author of the paper entitled “Using Complementary Models-Based Approaches for Representing and Analysing ATM Systems’ Variability” written in collaboration with Célia Martinie, Philippe Palanque, Alberto Pasquini, Eric Rigaud and Sara Silvagni.

The Second SESAR Innovation Days (http://www.sesarinnovationdays.eu/) DLR and the Technical University of Braunschweig, Germany, from 27th to 29th November 2012. She is co-author of the paper entitled “A framework for modeling the consequences of the propagation of automation degradation in air traffic control systems”. The other co-
authors are Eric Rigaud, Erik Hollnagel, Célia Martinie, Philippe Palanque, Alberto Pasquini, Sara Silvagni and Mark Alexander Sujan

These papers are in the annex at the end of the second year progress report provided by Martina to HALA! network.

3.2 Training Activities

Here is the list of training followed by Martina during this first year of the PhD.

GENSPACE: Discover Air Traffic Control, 10-13 May 2011, EUROCONTROL experimental centre Brétigny sur Orge, France. She attended practical demonstration of what air traffic control is and how it is performed in practice. The main aim was to give a bigger horizon on ATC, to non-operational persons working in different domains, connected in a way or another with ATM and who need to understand the work of Air Traffic Controllers from a practical point of view.

Summer School organized by HALA! SESAR Research Network, 11-14 July 2011; La Granja de San Ildefonso, Spain. The courses were organized by the Universidad Politécnica de Madrid. I attended all the courses which provided very pertinent and timely information for her PhD work (http://www.hala-sesar.net/sites/default/files/HALA_SUMMER_COURSE_v7.pdf).

Master 2 IHM: Master Interaction Homme-Machine (IHM) in collaboration between the Université Paul Sabatier (Toulouse 3) and the École Nationale de l’Aviation Civile (ENAC). She attended several courses related to my PhD research activity.

Visit at ENAC under the supervision and with the support of an ATCO, a professor in the Master IHM and a pilot instructor. She had the opportunity to visit:

- “Hall du NBS Maquette” for an introduction on ATM and the role of ENAC and an overview on the ELECTRA, SCANSIM and AUDIOLAN simulators
- “Salle EAO” for ATCOs training
- “Salle SCANSIM”: airport simulator and presentation of AUDIOLAN
- “Salle ELECTRA” (based on CAUTRA): it is possible to observe the different sectors as en – route sector with ODS, the approach sector with IRMA and the particular tasks required for each sector. In addition the role and the usage of the strips.

[5]
**Interactions and Bio-Informatics** a series of seminars organized by the “Ecole Doctorale Mathématiques, Informatique, Télécommunications (ED MITT) of Toulouse. They are mandatory and span over 18 hours. This doctorate-level teaching unit is divided in 3 parts: the first one deals with “Past and Future of Research in Interactive Critical Systems: Focus on Processes and Tools for Design and Evaluation”, the second one with “The Facets of Argumentation: Artificial Intelligence, Language Understanding, Discourse and Pragmatics” and the last one is focused on “Bio-Informatics”.

**The second Summer School: Research in decision support systems for future Air Traffic Management** organized by HALA! SESAR Research Network, 9-12 July 2012; La Granja de San Ildefonso, Spain. The courses were organized by the Universidad Politécnica de Madrid. I attended all the courses which provided pertinent information for her PhD.

**Generic Human Factors Training (GHFT)** organized by Deep Blue consulting & research, 20-27 July 2012; Rome, Italy. The course was taught by experienced experts in their respective fields and led the attendees to improved professional skills that are directly applicable. Blended training modules are designed including in-presence and e-learning formats and containing ad-hoc developed contents for lectures and project work.

In parallel to this theoretical training she has been involved as Human Factors analyst in the preparation, conduct, analysis and report in 2 Real-Time Simulations at the experimental centre of prototype systems of Ente Nazionale di Assistenza al Volo (ENAV S.p.a.) in Rome, Italy. This was very important to deepen her knowledge of the tools used in ATM by Air Traffic Controllers (ATCOs) and the interactions between them. In particular she took part in:

- **SESAR QM 5 - Operational Project 5.5.1. TMA Trajectory Management Framework**
  Validation of the Ground-Ground Coordination and further aspects associated to the introduction of i4D functionalities and of the Sequence tool CASL (Combined Arrival Sequence List).

- **SESAR QM 5 - Operational Project 5.6.4. Tactical TMA and En-route Queue Management**
  Validation of feasibility and evaluation of the operative impact in Rome ACC of the concept Extended AMAN
3.2.1 Progress with respect to the research

3.2.2 State of the Art

She has concluded the first round of work on investigation of current state of the fundamental concepts related to automation, modelling, resilience, degradation and its propagation in a system. For each of these notions she proposed a definition and contextualization in ATM domain. One of the critical element of this work was to keep the focus of attention on the core concept at the centre of the PhD i.e. the notion of degradation and more precisely how degradation impact the efficiency of (partly-) autonomous systems.

She produced a document “state of the art on automation with the literature review” that is the object of the Deliverable 4 (under review by Hala! SESAR Research Network). More precisely, she proposed an overview of the state of the art on automation with the aim to obtain a current and realistic picture of it and to identify the common features, challenges and previous contributions in different domains where automation plays a prominent role. Some of the domains taken into consideration are shown in Figure 2.
Beyond this state of the art on Automation Martina conducted several state of the art related to the scientific contributions in her PhD. Figure 3 presents a summary of such a state of the art in the area of Task Modelling.

<table>
<thead>
<tr>
<th>Requirements/Notations</th>
<th>RTA</th>
<th>DEVS</th>
<th>MAD</th>
<th>TKS</th>
<th>GTA</th>
<th>UAI</th>
<th>Dietre</th>
<th>VTML</th>
<th>CITE</th>
<th>AMBOSS</th>
<th>SAMANTA</th>
<th>HAMSTERS</th>
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<tbody>
<tr>
<td>REQ. 1. Concepts used to represent DK</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>√</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>√</td>
<td>X</td>
<td>X</td>
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<tr>
<td>REQ. 2. Refinement of concepts into states and into information</td>
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<td>X</td>
<td>Partly with objects (explicit)</td>
<td>X</td>
<td>Partly with objects</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Partly with objects</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>REQ. 3. Concepts should be made explicit</td>
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<td>X</td>
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<td>√</td>
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<tr>
<td>DEBSKAM (DK)</td>
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<td>X</td>
<td>X</td>
<td>√</td>
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<td>X</td>
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Figure 3. Comparison of task modelling notations according to suggested requirements (“√”=satisfied; “X”= not satisfied)

### 3.2.3 Work on Processes, Method and Notations

Large-Scale Socio-Technical Systems, such as Air Traffic Management (ATM), are organizations where different interconnected systems work together to achieve a common goal. Analysis of variability is particularly challenging in these systems of systems due to the non-linear and complex interactions among social and technical functions. This research work which is at the core of Martina’s PhD proposes a systematic approach able to represent and to reason about the variability of such socio-technical systems. The proposed approach is based on the synergistic use of 3 models able to represent the variability from different points of view. This federation of models focusses the analysis on the relevant aspects of the systems of systems at different levels of granularity. The models taken into account for the representation of system variability are FRAM [1] focusing on organizational functions, HAMSTERS [2], which is centred on human goals and activities and ICO [3] which is dedicated to the representation of systems’ behaviour (including the user interface). These notations are integrated within a detailed process that is presented in Figure 5.
It is important to note that the works carried out during the second year of the PhD has highlights limitations in the notations used and ended up with extensions to FRAM and HAMSTERS notations. For the first one we decided to associate functions to actors who perform the functions making explicit where automation takes place. As for HAMSTERS many detailed extensions have been proposed (and a paper detailing them is currently under review for a conference) in order to integrated declarative knowledge in the tasks models. Figure 4 presents a task model integrating both declarative and procedural knowledge.

Figure 4. A task model integrating procedural and declarative knowledge
Figure 5. The integrated process
3.2.4 Case studies

In parallel to this methodological work she worked on several case studies. Originally she worked on case studies such as the Arrival Manager (AMAN) which was also part of the SPAD project. In order to handle complexity aspects we decided then to move to smaller case studies such as the WXR which is a weather radar application (available in interactive cockpits of large civil aircrafts such as the A380) and even a simpler one called the game of 15. She focusses on a limited number of essential specific aspects of these case studies, using and developing upgraded version of existing models combined in a federation and used synergistically. Each model focusses on a specific characteristic (for example functional aspects, interactions and propagation, human behaviour and the interactions with the system) and represents a part of the whole application with variable levels of granularity. This federation considers human in the loop input (or even over the loop), dynamic planning algorithms and flexibility to determine the most adequate levels of control of autonomy. The objective of this method is to guarantee that interaction between models have a common meaning both at conceptual and technical levels. The federation of models shall be able to work at different levels of abstractions from basic underlying computer system till the top level made up of a system of systems interconnected.

This research activity is related to System Performances under Automation Degradation – SPAD project (http://www.irit.fr/recherches/ICS/projects/spad/index.php) financed by EUROCONTROL.

4 Scientific Production - Papers Publications of the First Two Years


Are omitted from this list poster presentations and doctoral consortium accepted submissions.

5 Final Considerations and Evaluation

Martina Ragosta has been a very active student during this first year. She integrated very well in ICS team both with permanent people and with the other students. During the second year she carried on working actively on her PhD starting to contribute to the definition of the core of her PhD content.

She made a lot of progress in French language making easing her communication with people especially with administrative people who typically only speak French. Both her understanding and speaking levels are perfectly adequate.

She very carefully and efficiently handled this second year on the administrative side meeting all the constraints that have to be fulfilled during the 3 years of the PhD. This is very important as now that she moved to DeepBlue (Roma) for her final year.
On the scientific side, the background of Martina (she mainly had a human-factor training) made it difficult for her to handle the computer science of her human-computer interaction PhD subject (as stated in the report of the first year). She made progress during the second year gaining maturity on the job of a researcher including analysis of the work done by other and the production of original validated contribution to a research domain. The structure of the content of her PhD thesis has been also finalized prior to her departure for DeepBlue. Provided that she carries on during the last year at DeepBlue I am confident that she will manage to complete her PhD. It is important to note however that the migration for the last year of the PhD in a different context with different working habits might be considered as a medium risk to be added to the traditional process of a PhD.

6 References