Automation of Trajectory based Operation for Future Flight Decks

2\textsuperscript{nd} Progress Report

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Glossary of terms used

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<tr>
<td>ATM</td>
<td>Air Traffic Management</td>
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<td>HALA</td>
<td>Higher Automation Level in Air Traffic Management</td>
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<td>HMI</td>
<td>Human-Machine Interface</td>
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<td>SESAR</td>
<td>Single European Sky ATM Research</td>
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<td>TBO</td>
<td>Trajectory Based Operation</td>
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<td>TUD</td>
<td>Technische Universität Darmstadt</td>
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Executive summary

This document is based on the research plan of my PhD work entitled “Automation of Trajectory based Operation for Future Flight Decks” and represents the current state of the ongoing research work. The second PhD progress report is based on the first HALA! progress report and describes the current status of the PhD research work and the completed tasks after one year of research.

The analysis of the required information for a flight under full 4D Trajectory based Operation (TBO) conditions are completed and the first step of the research question is finished. The classification of the additional information, using expert surveys, is completed and the next step is to develop a Human-machine-interface (HMI) based on these results.

The relevant research work is right in schedule and the general ideas could be confirmed. The next step will be the definition and development on a demonstrator including the additional information and the task flow on the flight deck.
1. Introduction and scope

On the flight deck of modern aircrafts, there are a high number of automated systems present to display and handle required information [1] for conducting safe and efficient flights. The large quantity of information cannot be further increased without increasing the human workload or creating more complex automated systems including decision support tools. This PhD thesis aims to develop a highly automated operating system for the flight deck to implement the required information for TBOs. It is aligned on the Single European Sky ATM Research (SESAR) objectives of automation and air traffic management (ATM) and will produce results, which can interlink with other projects performed with the HALA! Network. All generated results describe an overall operational concept for SESAR TBO.

1.1. Identification

In the scope of this document a report on the current status of the PhD research work is provided. The work started with researching and screening reports, technical standards and publications in order to become familiar with the current research work and to gain a deeper understanding of the topic. In addition an information analysis and an information classification were done.

1.2. Goal of this PhD research work

This PhD research work is developing a concept to integrate the required information for 4D TBO into a future cockpit design. This concept will be realized developing a demonstrator, its framework, and the implementation process of new operating system function to support TBO on future flight deck systems. This demonstrator shall be integrated into a Flight Deck to enable TBO functions and measure the human workload. The system is designed as a HMI system including automation. Furthermore the system shall provide additional information and functionalities that the pilot can better understand the past situation, can interact at present and can easier foresee the future situation.

1.3. Document overview

The purpose of this report is to describe the current status of my PhD work about Automation in Trajectory based Operation on Future Flight Decks. This document is divided into the following chapters:

- Section 1 describes the introduction and scope
- Section 2 contains the reference documents
- Section 3 provides the state of the research
- Section 4 gives an conclusion
2. Referenced documents

The following documents are referenced within this document.

3. State of the research

3.1. Research context

The 4D TBO approach for air traffic operations provides new responsibilities, tasks and information for the flight crew. Resulting from the mechanism of trajectory calculation, planning, negotiation and updating there are new tasks, requirements, roles and informational required. These completely new information requirements on the flight deck can be supported using new automation processing levels, information filtering, and decision support tools. This research work aims at managing these tasks and information by improving the perception of information by the pilot and thereby reducing the workload with the help of decision support tools and automated information processing systems.

3.2. Research concept

The human centered flight deck system analysis is the main activity of this PhD research work. The used ATM environment simulated will be full 4D. This 4D TBO concept defined and developed during the SESAR project will be used to describe a detailed uninterrupted flight track including time. A defined algorithm will do the definition and calculation of the complete trajectory. Unexpected events, constrains or changes will be continuously implemented into the trajectory. The communication of the trajectory will be done with state-of- the-art data link technologies. The research work will investigate how the pilot has to be supported in order to be able to manage and use the defined concept of 4D TBO. In addition the possible automation support level will be investigated to analyze the potential benefits of automation on the flight deck. To present the required information on the flight deck, additional system functions will be developed and implemented into the flight deck. The flight simulator at the Technische Universität Darmstadt (TUD) will be equipped with the new system functions to demonstrate the developed HMI. The design of the flight trials will be based on the outcome of the task and information analysis.

3.3. Current state and accomplished tasks

This research work is structured into a familiarization with the relevant literature and methods of the research field, an information analysis including expert knowledge, a state-of-the-art system analysis, a conceptual phase to define the required information and decision support tools, a demonstrator development phase, and a presentation phase including the experiment.
A first major part of the familiarization with the research field, current research questions and methods were researched. The first five-month period of the PhD thesis dealt with these topics. The results of the familiarization, the understanding and understanding of the system requirements are finished and these results are documented in the HALA deliverables D1-D4.

The main outcomes of till now are the following:
- Familiarization with the current ATM system
- Familiarization with current pilot tasks
- Understanding of the future ATM principles
- Understanding of human factors in the context of avionic systems
- Development of an HTA for the cockpit crew
- Development of an questionnaire for an expert survey
- A poster for the SESAR innovation days 2012
- A doctoral paper for the ATACCS 2013

The development of the research plan, a poster for the SESAR Innovation Days on November 26th, 2012 and a doctoral paper for ATACCS 2013 were the documents produced during the first months.

In addition to these tasks accomplished during the first period of my PhD research work, the information analysis on the flight deck is done. The analysis and classification dealing with the 4D TBO information on the flight deck was divided into different tasks. The first task was to analyze and classify the information available on current flight deck. Based on this classification, the additional information was dissected. With the help of expert interviews and expert surveys the information breakdown and classification was supplemented and reviewed.

3.4. Next steps

The results of the information analysis will be analyzed and based on the results of this first period the next step will be the definition of the demonstrator concept including the HMI. To evaluate the design of the demonstrator expert interviews will be done to take account the user and to evaluate the demonstrator design. With the outcome of this process the demonstrator will be developed and integrated into the research simulator.
4. Conclusion

The aim of the proposed PhD studies is to analyze what information is required for efficient 4D TBO on the flight deck and how the required information can be integrated into the future flight deck. This thesis will improve the cognition of information for 4D TBO by the cockpit crew using information automation.

The literature review has been conducted on the research area in this document in order to get a basic understanding on the different research priorities and research foci. One of the key elements of this work, the information analysis and classification is finished.

The next step will be the definition of the demonstrator based on these results. In addition to that main task, the usage of automation and automated process will be analyzed to develop the demonstrator and to support the flight crew.