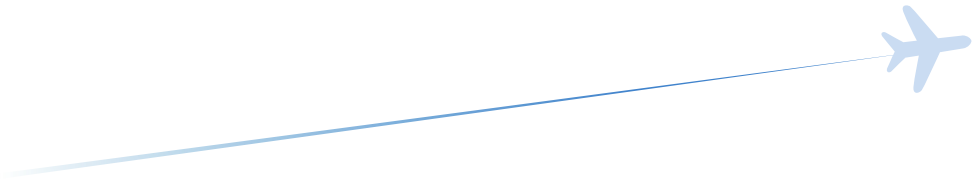

1st Workshop report

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Copyright Statement

MAHALO

MODERN ATM VIA HUMAN / AUTOMATION LEARNING OPTIMISATION

This deliverable is part of a project that has received funding from the SESAR Joint Undertaking under grant agreement No 892970 under European Union's Horizon 2020 research and innovation programme.

Abstract

This document contains all the related material to Workshop 1 with the MAHALO Advisory Board. Specifically Workshop agenda, participant list, workshop presentations and the received feedback from the advisory board. Additionally, it also contains minutes from the workshop and a conclusion & summary of actions section.

Table of Contents

List of Tables

1. Introduction

1.1 Scope of the document

The scope of deliverable *D7.2 Workshop reports* is to describe the workshop the MAHALO project conducted with its Advisory Board (AB) members and other stakeholders. This report will cover workshop agenda, participants, links to public access documents or materials discussed (if any), workshop minutes and a summary of actions.

1.2 Structure of the document

This document consists of 3 chapters and the contents are as follows:

- Chapter 1 describes the scope and structure of this document.
- Chapter 2 provides framework of the workshop itself, including objectives, agenda, participant lists and workshop material.
- Chapter 3 summarizes the workshop results and actions.

In addition, Minutes and Video link are added in the appendix section, Appendix A, Appendix B, respectively.

1.3 List of acronyms

Table 1 List of acronyms

Term	Definition
AB	Advisory Board
AI	Artificial Intelligence
AISA	AI Situational Awareness Foundation for Advancing Automation
ANACNA	Associazione Nazionale Assistenti e Controllori Navigazione Aerea
ANSP	Air Navigation Service Provider
ATCO	Air Traffic Controller
ATM	Air Traffic Management
CD&R	Conflict Detection and Resolution
CHPR	Center for Human Performance Research
ConOps	Concept of Operations
CEST	Central European Summer Time
EUROCONTROL	European Organisation for the Safety of Air Navigation

ML	Machine Learning
MUAC	Maastricht Upper Area Control Centre
RL	Reinforcement Learning
SL	Supervised Learning
TAPAS	Towards an Automated and exPlainable ATM System
TU Delft	Delft University of Technology
WP	Work Package

2 Workshop

The MAHALO project organized an online workshop on Thursday the 28th October 2021, between 14.00 – 18.00 CEST with the purpose of showcasing the work accomplished, i.e., Artificial Intelligence (AI) based Conflict Detection and Resolution tool and results of the first simulation, and gathering external experts' views on the upcoming final validation simulation planned for winter 2021 (in Italy) and spring 2022 (in Sweden).

The workshop was scheduled to coincide with the conclusion of Work Package 5 (WP5) Integration activities and was one out of two (the second event is planned for May 2022). A total of fourteen Advisory Board members and Air Traffic Management (ATM) stakeholders, comprising of experts from various fields of expertise, e.g. academic, Air Navigation Service Providers (ANSP), Machine Learning (ML) experts etc., attended the workshop. The MAHALO consortium also participated in this event. All sessions were carried out on Webex platform. Despite a virtual event, the MAHALO consortium ensured maximum effectiveness and high involvement from the participants throughout the workshop.

2.1 Objectives

The workshop objectives could be underlined as follows:

- Introduction of the MAHALO project to the Advisory Board members and stakeholders and paving the way for an increasing engagement of the project with stakeholders and ATM community;
- Presentation of a proof of concept for an AI based Conflict Detection and Resolution (CD&R) tool, able to provide solutions which may be based on real air traffic controllers' strategies (conformal solutions) or on AI-based optimisation;
- Presentation of alternative ways in which the AI can "Speak" with the controllers, providing information that enable them to understand why a specific solution has been proposed (Transparency);
- Presentation of the results of a first simulation carried out in autumn 2021;
- Involvement of the AB and stakeholders in concept development;
- Sharing MAHALO definitions for conformal, personalized and optimized resolutions with ATM stakeholders;
- Sharing different approaches on ML strategies;
- Transfer of methods and initial results to stakeholders in ATM community;
- Assure that the MAHALO research is in alignment with future visions of ATM.

2.2 Agenda

The outline of the workshop followed the structure presented in Table 2. The agenda of the workshop started with an introductory session providing general overview of the Mahalo project, and followed by a brief presentation on AI and automation to underline the MAHALO relations to AI. The workshop proceeded with three interactive sessions where the MAHALO consortium presented its ML prototype (i.e. Reinforcement Learning (RL), Supervised Learning (SL)), results of the project's first simulation with novice (i.e. TU Delft students), and the experimental plan for the validation simulations. After each of these interactive sessions, the participants were encouraged to ask questions, share their perspectives and provide feedback.

Table 2 Workshop agenda

Time	Activity
14:00	**Opening and Welcome**
14:05 – 14:20	Introduction of Participants
14:20 – 14:25	Workshop overview
14:25 – 14:35	General overview of the MAHALO project
14:35 – 14:45	Introduction to Artificial Intelligence (AI) and Automation
14:45 – 15:15	Session 1: MAHALO prototype
15:15 – 15:45	Discussion and feedback
15:45– 16:00	***Coffee Break***
16:00 – 16:20	Session 2: Results of the first simulation
16:20 – 16:50	Discussion and feedback
16:50 – 17:00	***Coffee Break***
17:00 – 17:20	Session 3: Experimental plan for the final validation simulations and expected outcomes
17:20 – 17:50	Discussion and feedback
17:50 – 18:00	Next steps and Wrap-up
18:00	**Closing**

2.3 Participants

As mentioned earlier that the workshop was attended by fourteen participants who were external experts from nine different organisations representing various fields of expertise and professional including academic, ANSP and ML gurus etc. Table 3 contains the list of organisations of the participants.

Table 3 List of Organisations of the Participants

Organisation	Type
Centrale Supelec	Academic
FERRONATS	ANSP
Deutsche Flugsicherung (DFS)	ANSP
ANACNA	ATCO association
EUROCONTROL	European body
SKYGUIDE	AISA project representative
ENAIRE	TAPAS project representative
Mälardalen University (MDH)	ARTIMATION project representative
MUAC	ANSP

2.4 Pre-Workshop Materials

The MAHALO consortium sent a ***formal invitation letter*** providing the project's ambition and detailing the workshop date and time as well as its objectives, to the AB members and stakeholders. Subsequently, an ***Introductory document*** was circulated to the confirmed attendees prior to the workshop. The purpose of the introductory document was to give an initial understanding of the MAHALO project, its research topic and approach including experimental design, the MAHALO Concept of Operations (ConOps), and expected impact and contribution to ATM. The abovementioned documents are attached below.

2.4.1 Workshop Presentations

During the workshop, one main presentation (***General Workshop presentation***) was used as a foundation. However, each presenter shared his/her respective portion by a separate PowerPoint.

Followings are the list of presentations and the attached documents/files that are contained at this specific link (to be opened preferably with Google Chrome):

https://drive.google.com/drive/folders/1CTTyV5a2XYpLl7DmrqSEbtgu_j7uyZUC?usp=sharing

2.4.1.1 General Workshop presentation

The Project Coordinator warmly greeted and welcomed the workshop attendees. Later there was a roundtable of the MAHALO consortium and the participants. Luftfartsverket (Project member) went through workshop objectives and agenda.

2.4.1.2 General Project presentation

A Project member from Deep Blue provided an overview of the MAHALO project i.e. project objectives, MAHALO research questions and abstraction.

2.4.1.3 Overview of AI & Automation

TU Delft (WP5 Leader) explained the principles of AI and automation including types of Machine Learning (ML) and their strengths, choice of ML used in MAHALO and disadvantages of AI.

2.4.1.4 Machine Learning approach - Supervised Learning

Linköping University (WP3 Leader) gave an introduction to the design of automation support and briefly explained conflict resolution advisories i.e. conformance and transparency. Linköping University also explained the supervised learning model and its goal.

2.4.1.5 Machine Learning approach – Reinforcement Learning

TU Delft (WP5 Leader) presented AI and ML, RL as well as the RL approaches for MAHALO.

2.4.1.6 Simulation Plans and experimental setup

Linköping University (WP6 Leader) and CHPR (WP2 Leader) presented the experimental plan for the validation simulations with active air traffic controllers taking place in winter 2021 (in Italy) and spring 2022 (in Sweden).

3 Results, Conclusions and Summary of Actions

3.1 Workshop feedback

The feedback collected from the workshop are documented in the following forms:

- **Minutes**, captures the general discussions during the workshop where feedback was gained by verbal interaction (see Appendix A).
- **Miro Board Interactive session**, the online tool "Miro Board" was used to literally and graphically capture feedback. The participants used virtual "sticky notes" to communicate their thoughts, perspectives and provide feedback on three specific research questions;

    1. ***If automation is to support controllers in their work, what would be meaningful to personalise in the task of conflict detection and resolution (CD&R)?***
    2. ***What needs to be explained (be made transparent) for the controller to understand the reasoning of an ML agent supporting the controller in CD&R?***
    3. ***How can we measure the extent to which the operator understands the automation?***

The attendees were grouped in four separate breakout rooms where they had the opportunity to individually reflect on the questions, and also discuss within the group.

The Miro Board Interactive session results have been converted into a pdf format and stored in the same folder with presentations (to be opened preferably with Google Chrome):

https://drive.google.com/drive/folders/1CTTyV5a2XYpLl7DmrqSEbtgu_j7uyZUC?usp=sharing

3.2 Conclusions and Summary of Actions

Overall, the workshop brought valuable input from domain expertise. There were generally good interest and engagement from the participants. The introduction and presentation of the MAHALO concept as well as the initial simulation results were well received and understood by the attendees. This resulted in interesting discussions on the chosen strategies and alternative approaches. It can therefore be concluded that the workshop objectives were achieved.

The outcomes of the workshop specifically resulted in:

- The project team concluded that using scenarios in up to twice the speed would be feasible and ensure enough realism. This was a highlighted concern and discussed during the workshop. Feedback gave the MAHALO project team insight into the issue and confirmation that this has been done in other validations without significant deterioration of realism;
- The ability to continue the work on the validation scenario approach and definition;
- Awareness of the importance of situational awareness and understanding the overall plan in conflict situations;
- Increased insight on how AI approaches within the context of ATM could be structured to achieve sufficient involvement of the human in a safety critical environment;
- Improved understanding of the relation to other AI/ML projects.

Appendix A

EXPLORATORY RESEARCH

MAHALO

Workshop Minutes

Grant:	**892970**
Call:	**H2020-SESAR-2019-2**
Topic:	**SESAR-ER4-30-2019**
Consortium Coordinator:	**Deep Blue**
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Disclaimer

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MAHALO

MODERN ATM VIA HUMAN / AUTOMATION LEARNING OPTIMISATION

Workshop Minutes

28th October 2021, 14.00 – 18.00 CEST

This project has received funding from the SESAR Joint Undertaking under grant agreement No 892970 under European Union's Horizon 2020 research and innovation programme.

MAHALO Workshop

Workshop objectives

The purpose of the workshop is to exhibit the work accomplished, i.e., Artificial Intelligence (AI) based Conflict Detection and Resolution tool and results of the first simulation, and gathering external experts' views on the upcoming final validation simulation planned for winter 2021 (in Italy) and spring 2022 (in Sweden).

List of organisations of the participants

Organisation	Type
Centrale Supelec	Academic
FERRONATS	ANSP
Deutsche Flugsicherung (DFS)	ANSP
ANACNA	ATCO association
EUROCONTROL	European body

SKYGUIDE	AISA project representative
ENAIRE	TAPAS project representative
Mälardalen University (MDH)	ARTIMATION project representative
MUAC	ANSP

Agenda

Time	Activity
14:00	**Opening and Welcome**
14:05 – 14:20	Introduction of Participants
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16:50 – 17:00	***Coffee Break***
17:00 – 17:20	Session 3: Experimental plan for the final validation simulations and expected outcomes
17:20 – 17:50	Discussion and feedback
17:50 – 18:00	Next steps and Wrap-up
18:00	**Closing**

Minutes

1) Welcome by Project Coordinator

Presenter: Deep Blue (DBL)
DBL warmly greeted and welcomed the workshop attendees. Later there was a roundtable of the MAHALO consortium and the participants.

2) Workshop overview

Presenter: Luftfartsverket (LFV)

LFV went through workshop objectives and agenda.

3) Overview of MAHALO project

Presenter: DBL

DBL provided an overview of the MAHALO project i.e. project objectives, MAHALO research questions and abstraction.

4) Introduction to AI and Automation

Presenter: TU Delft

TU Delft explained the principles of AI and automation including types of Machine Learning (ML) and their strengths, choice of ML used in MAHALO and disadvantages of AI.

5) MAHALO prototype: Supervised Learning (SL)

Presenter: Linköping University (LiU)

LiU gave an introduction to the design of automation support and briefly explained conflict resolution advisories i.e. conformance and transparency. LiU also explained the supervised learning model and its goals.

6) MAHALO prototype: Reinforcement Learning (RL)

Presenter: TU Delft

TU Delft presented AI and ML, RL as well as the RL approaches for MAHALO.

Comments / Questions:

MUAC: Comfort with the machine depends a lot on the ability to follow the plan that the machine has for managing the traffic. What is the overall plan? How can we capture that?

LiU: We could have more than one conflict and train the system to address these in the same order that the human is. That is a level of conformance that is important to consider.

EUROCONTROL: It's important to state the objectives of AI or automation is at the end.

TU Delft: We see that ATCOs have supervisory role, and can make decision in the end whether to accept or reject.

EUROCONTROL: Understandability is more important than the performance benefits itself.

TU Delft: We're not sure if we can create an advice that has explainabilities into account.

EUROCONTROL: Subjective optimality is conformance. Objective optimality is measure. We need both. ATCOs will through away optimal solutions and therefore not be ok with it. We need subjective optimality to gain ATCOs trust. Once gained, then we can include the objective optimality into the rewarding system.

TU Delft: We start from the conformal one, then progress to optimal one. We in this stage, research into the future.

LFV: What about forced optimality?

EUROCONTROL: We need to explain, first transparency then we gain trust. Forced optimality is not working. We need both, more conformance in the beginning and gradually transition to optimality. If we can explain optimal solutions, then ATCOs tend to trust the ML and accept the advice from the system. But if no explain/transparency, they would reject it. We need more conformal.

Centrale Supelec: Over-trust doesn't analyse self. If under-trust or lose trust, it is difficult to come back if it gets to that point. Over-trust leads to accident in cockpit. When you over trust the system, and there's a time when you lose trust in the machine, it's very difficult to get that back. Humans don't take same input or data as algorithm. We should consider over and under trust. People shut down the automation if they lost trust. Centrale Supelec solved a lot of issues in cockpit automation.

Centrale Supelec: What do we mean by optimality? The meaning by the human and machine is different.

TU Delft: What is optimal in ATC, depending on stakeholders. For ATCO, it might be easy on eyes or something that reduces workload. ATCOs take into account workload, understandable. For airlines, it is about straight routes. We need to find balance.

EUROCONTROL: ATCOs might like a solution with less workload. But for machine, it is different. Controllers manage their own workload, favour easy resolution. If machine generates solution that ATCOs accept, it is better. It is a balance but important that ATCOs accept resolution.

MUAC: Trust is important. But for ATCOs, it is a comfort, meaning they tend to take the solutions that are comfortable. But if they have to take what the machine does, they have to be in the loop, to know the overall plan of the machine, know all the flights. If ATCOs trust the machine but don't like the plan, they lose trust. The plan should make sense for ATCOs. They should be able to see beyond an action.

TU Delft: How to capture the plan? Part of explanation is to present the plan.

MUAC: A plan is a set of actions, one-multiple, the overall plan is essential. Yes, the ATCO should need to have that.

ANACNA: Learning system, we are talking about normal conditions. What about other situations e.g. bad weather, ATCO not following the path due to this/that, will automation understand this? Will it continue like it would be normal? Would the system be able to cope and manage such situations?

TU Delft: Training could include this. Optimality can be trained for RL account for non-normal factors, SL needs to include training scenarios too. It depends on the ML training. We can have virtual scenario setup and let the agent trains. We don't need human to be in the loop. If no training, agent will not know what to do.

FERRONATS: Priority given to each instruction, design a plan for solving several conflicts and including a priority and order, it is not the same thing.

TU Delft: Goal is that system can consider everything in sector. However, it's not part in the concept at this moment. Indeed, it is important. We create strategy solutions. Train machine to react.

CHPR: Issue in defining conformance is also particular aircraft over another one. How similar is agent solution have to be?

ANACNA: Trust! Experienced vs un-experienced ATCOs will react differently. It would use a lot of mental workload to understand. This is important to highlight.

TU Delft: Explained that research has shown differences. T this will show up in personalized models.

SKYGUIDE: Mentioned the approach how to bring more trust into AI. Comparison SA between AI and human, how similar the resolutions are. If you bring in AI, it must be lower levels of automation, e.g. warnings, but not conflict solution, into building trust. Build up from "would you like to do this" to CD&R. ATCOs have many solutions to solve a conflict. We compare AI solutions and human ones i.e. why are they different/similar.

TU Delft: Agreed with a gradual process. We are doing this in the upcoming simulations.

ENAIRE: Algorithm should try to compromise. For reward, it's important to use system to minimize conflicts and solution does not generate new conflicts. Also, it should include parameters e.g. flown miles and so forth.

7) Results of the first simulation

Presenters: TU Delft

TU Delft presented scopes and objectives of the simulation (SIM1), and how it was set up. Preliminary results and lessons learned were also presented to the participants. TU Delft ended the presentation by explaining "SectorX", the simulator used in MAHALO.

Comments / Questions:

EUROCONTROL: Asked about the timeline. At which point when the advisory should be presented in order to maximize the acceptance? If resolution advisory comes after controller has solved it, then there is a problem. There is an optimum time for when to provide the solution. Important balance, how have you tackled that?

TU Delft: We personalize how early, also when the advisory will be presented. In the final simulation, ATCOs cannot interact with the simulator. Some ATCOs might want to solve conflict quicker than the others. We don't know yet how this consistency would be. We need to investigate this. If there's a lot of variation, it'd be difficult for us to say when the advisory should be presented.

EUROCONTROL: Is it configurable parameter? ATCO as part of interface can control the timing.

TU Delft: Yes perhaps, we could use that (when advisory is presented).

ANACNA: Scenario is depended on the situation, e.g. no-flying zone, no direct path anymore, could be even more complex. De-conflicting strategy also depends on situation. Problem is that it's not realistic because there's no military activity, or restricted area in the scenarios. Normally, ATCOs would try to solve conflict in the easiest way and also to see who could be traffic involved. No such pre-defined traffic scenario.

LFV: How severe is it to restrict to only heading resolution?

ANACNA: Normally, heading is most used and easiest, vertical is less convenient. Both ATCOs and pilots prefer heading than to climb/descent. It doesn't matter how much turn it is.

LiU: We intend to use short vignettes and use already traffic and speed up time, how do you feel about that?

ANACNA: Normally, we speed up traffic in simulations if nothing happens. This is ok for en-route (ACC) environment, but not for terminal area (APP). They have used x2 speed if traffic is low. If higher, traffic more difficult to adapt to increase in speed.

CHPR: What have we forgotten, in terms of scenario design?

MUAC: It depends on what we want to capture. For MAHALO scenarios, it's good enough because traffic is quite structured. But if we want to capture more than AI solutions, the scenarios can be more complex. And for that, you can add many more factors. It's a good start with these scenarios.

EUROCONTROL: Suggested that MAHALO should consider sector-less/flight centric than conventional sectors in future experiment. This setting will change how ATCOs work and plan for traffic.

8) Experimental plan for the final validation simulations and expected outcomes

Presenter: Linköping University (LiU)

LiU presented the experimental plan for the validation simulations with active air traffic controllers taking place in winter 2021 (in Italy) and spring 2022 (in Sweden).

Comments / Questions:

EUROCONTROL: What is the group average? Can we in all instances apply group average? If one like using speed, other likes heading, how do we build this group average.

LiU: We discussed it and found it difficult. The idea "one size fits all" is not likely to work. We think that we will have to see what the data generates.

EUROCONTROL: Mentioned a research project where one solution was given to one group but the other group was given several solutions. Choose different levels of automation. Varies solution they could pick amongst different solutions.

EUROCONTROL: Commented that 2-min scenarios seem too short and shocking. They are obvious. ATCOs might like to see traffic evolving.

LiU: Balance between generating enough training data. In simulation, we use longer scenarios.

9) Miro sessions

Presenter: LiU

Using the online interactive tool "Miro", LiU posted the following questions. The participants could directly write their comments/thoughts down on the Miro board.

1. **If automation is to support controllers in their work, what would be meaningful to personalise in the task of conflict detection and resolution (CD&R)?**

Comments / Thoughts:

- Allow dynamic preference settings. Depending on the situation ATCOs should be able to ask the system to provide a different type of solution (e.g. vectoring, speed, vertical, etc.) For example in case of bad weather ATCO could prefer to have resolution advisories based on vertical movements.
- Task Categories /individualized preference.
- Resolution strategy (although not certain at this stage what they might be; maybe more complex than just heading vs speed vs flight level).
- Safety margin, i.e. separation (greater than 5NM) the controller would typically allow.
- Lead time to detect and solve conflict.
- Advisories more in the planning environment = conflict-free closed trajectories for the entire sector (can be a HDG with a specific turn- back point too), which do not need to be personalised as opposed to the tactical decisions.
- Priorities for detection.
- Type of action: heading, speed, FL time to act.
- Personalise time and separation minima NM considered for alerting the user and provide them with a resolution.
- If there is an intuitive way of indicating why automation picked a certain solution (e.g. the ATCO would vector the a/c but automation says drop it because of other reasons), then we don't need as much personalisation.
- Flows selected/acted upon.
- "Level of anticipation" (early vs late resolution).
- Resolution strategy (level, heading, speed).
- It would be good to make ML more explicit: what kind of algorithm.
- Type of detection tools.
- If ML is neural nets, then they should be at the skill level (Rasmussen's model), not highest levels of automation.
- Min separation, time to conflict, separation after resolution, urgency in instruction.
- Time of detection. Conformity is not so important, as long as it's not too strange. You ask 10 controllers, you get 15 different ideas...and a discussion what is best.

2. **What needs to be explained (be made transparent) for the controller to understand the reasoning of an ML agent supporting the controller in CD&R?**

Comments / Thoughts:

- Contextual elements should be highlighted so that the choice of a particular solution over the others becomes more understandable.
- How certain the ML agent is of the given resolution?
- Aircraft concerned by the conflict and aircraft limiting the resolution (to avoid secondary conflicts).
- Time until conflict and separation at closest points.
- The 'quality of the resolution, i.e. track miles, fuel burn, time in sector.
- "1. Urgency (time) & severity (NM), 2. A/C involved, 3. Reason of picking one solution over another one (e.g. other potential conflict, contrail avoidance, etc.)."
- The type of conflict.
- What are the possible solutions?
- Minimum time of reaction.
- "1. Conflicting a/c, 2. Type of conflict, 3. Remaining time to conflict."
- Impact of the solutions in terms of resolution of conflicts and affected flights (some statistics can be included: NM, fuel, time flown reduced, etc.).

- Other traffic, min separation now, min separation after resolution, time to execute, priority instruction for separation or optimisation or LOA constraints.
- Explanation should be understandable in real time.

3. How can we measure the extent to which the operator understands the automation?

Comments / Thoughts:

- Like situation awareness, is it necessary to measure understanding? Why not just measure the success/outcomes of a correct understanding?
- Time to react to a proposed solution.
- "Quantative - how many are accepted, rejected.
- Subjective - debriefing why rejected, accepted"
- Time before accept/reject?
- Think aloud protocol.
- Probing/testing the resolution, e.g. mouse clicks, eye tracking etc.
- Amount of Ras consulted vs. accepted / rejected.
- Debriefing/SA level 1.
- Time spent on consulting an advisory.
- Over the shoulder observations, questionnaires on SA (compare the data retrieved with different levels of automation).
- Number of times a successful solution is rejected/number of times an unsuccessful solution is accepted. Hidden explanations and only show them if the ATCO displays it. Then you can measure how many times the ATCO checks.
- Understanding in a two-way problem. Controllers should be trained: human machine teaming.
- Accepting or not the proposal.
- Feedback on the system.
- Propose a list of solutions, and see what they pick....they will not select what they don´t understand let ATCO come up with alternative solution and compare measure time before selecting just highlight the proposed value and execute or change the value.

10) Participants' comments sent in chat room

DFS: My thoughts are more basic in the sense what is really the benefit for the business and the ATCO, I see a lot of interactions with the automation which will be done easier and more fluent with another human.

EUROCONTROL: Thoughts for the future/perspectives: how could you integrate airborne AI (autopilot, autonomous aircraft) that might surprise the ATCO in the near future?

Appendix B

Meeting Video Recording

The recording was started from the session "*General overview of the MAHALO project*" and throughout the workshop. The video can be viewed at the following link (to be opened preferably with Google Chrome):

https://drive.google.com/drive/folders/1FMZBlQ9Wrk4MDTHSx7F6laBnlPM2fbYO?usp=sharing