CARE/ASAS Action

CARE/ASAS Activity 3: Airborne Separation Minima - Presentation of the two selected applications
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1. INTRODUCTION

In the CARE-ASAS Activity 3 study, two groups of applications, Co-operative Separation Assurance and Autonomous Operations (AO) are considered. One application per group has to be selected for a detailed study: an OSED and an OHA will be realised for each of them.

The first task (Task1.0) of the WP1 “Identification of ASAS Operational Scenarios” of the CARE-ASAS Activity 3 study consists in selecting these two applications.

The purpose of the document is to present the results of this first task that is to present the two applications which are selected and the reasons why they have been selected. A list of issues which will have to be considered during the work is also presented for each application.

The approach adopted to select the applications is to consider the applications identified in the CARE-ASAS Activity 1 study, which consisted in the evaluation of past studies in the ASAS domains, and to select one of them for each group of application, respecting selection criteria defined for the CARE-ASAS Activity 3 study.

The CARE-ASAS Activity 3 study is a pioneering study as no previous studies have been done in the airborne separation minima domain. The selection criteria were identified as those that will produce the most effective results for the CARE-ASAS Activity 3 study and reduce the risks of not completing the work. Thus the applications selected have to be:

- Well known by the consortium members
- Not trivial; they shall reflect real situations (e.g. real conflict configurations)
- Defined in a simple environment (e.g. to avoid specificity of ground infrastructures).

2. CO-OPERATIVE APPLICATION

2.1. List of existing co-operative applications

Several existing co-operative applications along with the work performed to assess them have been identified in the CARE-ASAS Activity 1 study and are listed in Table 1. In addition to these applications, the En-Route Station-Keeping, as proposed by CENA, has been considered as it is another ASAS application not presented in the CARE-ASAS Activity 1 study but considered in the MA-AFAS project. This list is not exhaustive and includes only the ASAS applications referenced during the CARE-ASAS Activity 1 frame work.

These applications are summarised in Table 1.

<table>
<thead>
<tr>
<th>Applications</th>
<th>Airspace</th>
<th>Responsible</th>
<th>Work done</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossing and Passing</td>
<td>En-Route</td>
<td>EEC/FREER FLIGHT</td>
<td>- Pilot’s interface definition and development (e-cockpit and Multi-Cockpit Simulator)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Procedure and phraseology</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Real-time simulations</td>
</tr>
</tbody>
</table>
2.2. **Criteria of selection**

The criteria applied to select the co-operative application are the following ones:

- Maturity of the application
- Interest from ATM community
- Most promising for ATM community
- Knowledge of the CARE-ASAS Activity 3 team
- Address the maximum of relevant issues for the assessment of the airborne separation criteria.

2.2.1. **Maturity**

The maturity of the application corresponds to the status of validation of the application and depends on the number of issues which have been identified and resolved. Different
status of validation can be identified from the expert judgement through fast-time simulations to real-time simulations to flight trials. To cover the maximum of issues it is important to conduct different kinds of simulation so as to increase the knowledge and the definition of the application. The purpose is to have a clear view on all the points which have to be considered, e.g. as those highlighted in the CARE-ASAS Activity 1 review.

- CNS requirements
- Decision Support Tool: e.g. CD&R algorithm, CDTI definition
- ATM Performance issues, e.g. capacity, safety, efficiency results and transition aspects
- Human factors
- Economical aspects
- Institutional aspects, e.g. procedures, rules, responsibilities.

The maturity is also linked to the extend of the consensus in the ATM community.

2.2.2. Interest from ATM community

The interest from the ATM community can be seen as the perception the ATM community stakeholders have about an application and how the application can respond to their needs e.g. if the application is a continuity with present ATM, if it has a reasonable time frame or if it addresses real operational problems. The interest for an application is not measurable but is reflected, in particular, by the number of studies about this application.

The applications listed in table 1 concern different types of airspace and the interest they raise may depend on the users of the applications. Indeed the various ATM community stakeholders, e.g. pilots, airlines, en-route and approach controllers, may be interested in a new application rather than an other one according to the problems they encounter in their activities and the way the application addresses their problems.

2.2.3. Most promising for the ATM community

The most promising applications are the applications which are supposed to bring the maximum benefits. Although no quantitative measures have been produced, qualitative indications concerning potential benefits are available. The benefits which are expected are:

- Maintain or improve safety
- Increase of capacity
- Increase of flight efficiency
- Interoperability (Europe & World).

2.2.4. Knowledge of the CARE-ASAS 3 team

As mentioned in the Introduction section, to produce the most effective results and to reduce the risks of non completing the work and not finding separation minima results, it is relevant to take benefits of the knowledge of the CARE-ASAS Activity 3 team and consequently to select one application already studied by one of the members.
2.2.5. Address the maximum of relevant issues

The goal of the study is to perform a sensitivity analysis of the various factors which may impact the airborne separation minima and to provide a first estimation of the airborne separation minima (using the TOPAZ methodology) as such it is important to address different kinds of application with different geometrical configurations. The co-operative application can be divided into two sub-classes as proposed by the EMERALD study: “shadowing” and “distancing” applications. The distancing application concerns “aircraft which are close to each other for a very short duration”. Shadowing application concerns “aircraft which are required to stay at the same distance for some time”. (Definitions proposed in EMERALD WP5.5 Report.)

As it is more probable to encounter distancing applications (e.g. crossing configuration) in the autonomous aircraft application, it is more interesting to work on a shadowing application to address both configurations.
2.3. **Choice**

Regarding the proposed list of applications (Table 1) and the criteria of selection, the following matrix is proposed:

<table>
<thead>
<tr>
<th>Applications</th>
<th>Maturity</th>
<th>Interest</th>
<th>Promising</th>
<th>Knowledge</th>
<th>Configuration</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossing and Passing</td>
<td>Advanced</td>
<td>Medium</td>
<td>Few</td>
<td>Yes</td>
<td>Distancing</td>
<td>Under development and evaluation</td>
</tr>
<tr>
<td>ASAS Crossing Procedure</td>
<td>Medium</td>
<td>Medium</td>
<td>Few</td>
<td>Yes</td>
<td>Distancing</td>
<td>Defined as an example to highlight ASAS application; study suspended</td>
</tr>
<tr>
<td>En-route Station Keeping</td>
<td>Low</td>
<td>Medium</td>
<td>Few</td>
<td>Yes</td>
<td>Shadowing</td>
<td>Under development</td>
</tr>
<tr>
<td>Sequencing and Merging</td>
<td>Advanced</td>
<td>High</td>
<td>Very</td>
<td>Yes</td>
<td>Shadowing</td>
<td>Under development and evaluation</td>
</tr>
<tr>
<td>Station Keeping Contract between pilot and controller</td>
<td>Low</td>
<td>Unknown</td>
<td>Unknown</td>
<td>No</td>
<td>Shadowing</td>
<td>Study suspended</td>
</tr>
<tr>
<td>Station Keeping</td>
<td>Medium</td>
<td>High</td>
<td>Very</td>
<td>No</td>
<td>Shadowing</td>
<td>Example selected to cover some issues of the RTD plan of EMERALD; study completed</td>
</tr>
<tr>
<td>Closely Spaced Parallel Approach (CSPA)</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>No</td>
<td>Shadowing</td>
<td>Example selected to cover some issues of the RTD plan of EMERALD; study completed</td>
</tr>
</tbody>
</table>

- Considering the applications listed previously, two of them (Crossing/Passing and Sequencing/Merging) have been assessed through real-time simulations which can be considered as an advanced stage in the assessment of the application (at least in the assessment of the procedure, the phraseology and pilot’s interface). As such these applications can be considered as the most mature ones.
• The Sequencing/Merging (or Station Keeping) raises a strong interest from the totality of the ATM community as this application responds to an operational issue which is to increase arrival flow management.

• The Sequencing/Merging (or Station Keeping) application is seen as a very promising application which could bring benefits.

Although there are no quantitative results concerning these benefits, it can be said that expected benefits are:

- Maintain or improve safety
- Increase of capacity
- Increase of flight efficiency
- Optimisation of the Extended TMA and TMA management
- Optimisation of the airport arrival management.

• The Sequencing/Merging is still under development and evaluations at the EEC which is a relevant and useful aspect as both the CARE-ASAS Activity 3 and EEC projects could benefit from each other. It responds to the “knowledge of CARE-ASAS Activity 3 team” criteria.

• As mentioned in Section 2.5.5, the Sequencing/Merging application addresses a different kind of configuration than the one which will be studied in autonomous aircraft application.

As a consequence:

The Sequencing/Merging in TMA is the co-operative application which will be studied in the CARE-ASAS Activity 3 as it is the most mature one, well known by the consortium and very promising raising a lot of interest from all ATM community stakeholders.

2.4. Open issues

The Sequencing/Merging application will be the reference application. Nevertheless some open issues are raised and should be covered during the realisation of the OSED (WP1) and the OHA (WP2).

The following issues are highlighted:

• Time or distance spacing or both

• Sequencing only or Merging and Sequencing (if there is an impact to distinguish both applications)

• Communication aspects: use of CPDLC, air-to-air communication

• Aircraft equipment mix:

  - Either all the aircraft are ADS-B equipped, or
  - Use of the TIS-B for the non-equipped aircraft

• Cockpit automation assumptions: on-board assistance to support Station-keeping procedure

• Needs for ATC automation
• Ending conditions of station keeping (at FAF? on the ground?) along with the different associated benefits and constraints.

Solutions for these issues will be proposed to the CARE-ASAS Action Manager as soon as they are sufficiently mature. When available, the work already performed by the projects addressing station keeping issues (e.g. those listed in the CARE-ASAS Activity 1 study, MA-AFAS, NUP, MFF, ADS Programme) will be taken into consideration to answer some open issues.

3. AUTONOMOUS AIRCRAFT APPLICATION

3.1. Review of the existing work about autonomous aircraft application

Both the NLR and the EEC have studied the Autonomous Aircraft application as showed in the CARE-ASAS Activity 1 report.

The work performed by each of them is:

NLR:
• CNS requirements
• CDTI enhanced with ASAS functions
• Conflict Detection and Resolution (CD&R) algorithm
• Real time simulations involving pilots to assess the workload of the pilots and the acceptability of such application

EEC:
• CNS Requirements
• CDTI enhanced with ASAS functions
• CD&R algorithm
• Real time simulations involving pilots to assess the feasibility of the applications and the required ATC/on-board assistance
• Extended Flight Rules (EFR) and procedures defined

3.2. Definition of the application context

In the CARE-ASAS Activity 3 study it has been decided that the environment has to remain simple and compatible with the WP3 activity, e.g. with the TOPAZ tool and with the effort allocated to the WP3.

In that context, the following assumptions are made:

• Environment of the FFAS
  – No radar coverage (e.g. Mediterranean airspace)
• Aircraft equipment:
  – ADS-B equipped
3.3. Open issues

Some open issues are raised and will be covered during the WP1 and WP2. These open issues are:

- FFAS: With or without ATC support; if there is an ATC support, this available support for the controller should be detailed.
- MAS-FFAS transition issues: Covered or not
- Military aircraft presence
- Communication aspects: air-to-air data link communication or VHF between pilots, CPDLC or VHF if ATC support
- CD&R:
  - Surveillance information level: flight state and/or TCPs (Trajectory Change Point)
  - Resolution strategy: reactive or planning
  - Co-ordination strategy: simultaneous or sequential
  - Look ahead time considered
- Use of EFR.
- Fixed or user-preferred routes
- Full or partial equipment
- Density of traffic (low/medium/high)
- Geometry of the application
- Time or distance separation, or both.

Again, solutions for these open issues will be proposed to the CARE-ASAS Action Manager as soon as they are sufficiently mature. When available, the work already performed by the projects addressing station keeping issues (e.g. those listed in the CARE-ASAS Activity 1 study, MA-AFAS, NUP, MFF, ADS Programme) will be taken into consideration to answer some open issues.
4. ACRONYM LIST

ADS-B: Automatic Dependant Surveillance - Broadcast
AO: Autonomous Operation
CD&R: Conflict Detection and Resolution
CDTI: Cockpit Display of Traffic Information
CPDLC: Controller-Pilot Data Link Communications
CSPA: Closely Spaced Parallel Approach
FFAS: Free-Flight Airspace
MAS: Managed Airspace
OHA: Operational Hazard Analysis
OSED: Operational Service and Environment Definition
TIS-B: Traffic Information Service Broadcast

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