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# APPLICATION OF AIRBORNE CONFLICT MANAGEMENT: DETECTION, PREVENTION, & RESOLUTION

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## TABLE OF CONTENTS


1 PURPOSE AND SCOPE ..... 1

1.1 Introduction ..... 1

1.2 Background ..... 2

1.3 Operational Purpose and Justification ..... 4
1.3.1 Safety ..... 4
1.3.2 Capacity and Efficiency ..... 6
1.3.3 Infrastructure ..... 7
1.3.4 Environmental Impact ..... 8

1.4 Intended Airspace Domains ..... 8

1.5 Maturity and User Interest ..... 9
1.5.1 Conflict Detection ..... 9
1.5.2 Conflict Prevention ..... 10
1.5.3 Conflict Resolution ..... 11
1.5.4 Simulator and Flight Testing ..... 14

2 ACM CONCEPT ..... 19

2.1 ACM Overview ..... 19

2.2 Conflict Zones ..... 22
2.2.1 Protected Airspace Zone (PAZ) ..... 23
2.2.1.1 PAZ Purpose ..... 23
2.2.1.2 PAZ Description ..... 23
2.2.1.3 Suggested Initial PAZ Parameters ..... 24
2.2.2 Collision Avoidance Zone (CAZ) ..... 24
2.2.2.1 CAZ Purpose ..... 24
2.2.2.2 CAZ Description ..... 25

2.3 Conflict Detection ..... 25
2.3.1 Conflict Alert Thresholds ..... 25
2.3.1.1 Low Level Conflict Alerts ..... 26
2.3.1.2 PAZ Alert ..... 26
2.3.1.3 PAZ Penetration Notification ..... 27
2.3.1.4 CAZ Alert ..... 27
2.3.1.5 Alert Sequencing ..... 27
2.3.1.6 Example Conflict Alert Thresholds ..... 27
2.3.1.6.1 PAZ Alert Threshold – Example Parameter ..... 28
2.3.1.6.2 CAZ Alert Threshold – Example Initial Parameter ..... 28
2.3.2 Notional, Graphical Depiction of Zones, Areas, and Thresholds ..... 28
2.3.3 Example Effects of Encounter Geometry and Abnormal Conditions on Alert Thresholds ..... 29
2.3.3.1 Alert Zones Vary According to Encounter Geometry ..... 32
2.3.3.1.1 Effect of Closure Rate on Thresholds ..... 32
2.3.3.1.2 Effect of Vertical Rates on Thresholds ..... 34
2.3.3.2 Offset Intruders ..... 36

2.3.3.3 Pop-up Intruders ..... 37
2.3.3.4 Maneuvering ..... 38

2.4 Conflict Prevention ..... 40
2.4.1 Conflict Prevention Alerting ..... 40
2.4.2 Conflict Prevention Guidance ..... 41
2.4.3 A Conflict Prevention Example ..... 41

2.5 Conflict Resolutions ..... 41
2.5.1 General ..... 41
2.5.2 Low Level Alert Resolutions ..... 42
2.5.3 PAZ Conflict Resolutions ..... 43
2.5.4 CAZ Conflict Resolutions ..... 43

2.6 Airspace Operations ..... 44
2.6.1 General Background ..... 44
2.6.1.1 Graphical Depictions ..... 45
2.6.2 Operation in Specific Airspace ..... 47
2.6.2.1 Autonomous Airspace ..... 47
2.6.2.2 Managed Airspace ..... 48
2.6.2.3 Unmanaged Airspace ..... 48

2.7 Pilot-Controller Roles and Responsibilities ..... 48
2.7.1 Information Exchange ..... 49
2.7.2 Pilot and Controller Separation Responsibilities ..... 49
2.7.2.1 Unmanaged Airspace ..... 49
2.7.2.2 Managed Airspace ..... 49
2.7.2.3 Autonomous Airspace ..... 50

2.8 Equipage and Operational Issues in a Mature Free Flight Environment ..... 50

3 ACM/ACAS /ADS-B INTEROPERABILITY ..... 51

3.1 ACAS and ACM Installed on the Same Aircraft ..... 51
3.1.1 Conflict Alerts ..... 52
3.1.2 Resolutions ..... 52

3.2 ACM/ACAS Interoperability Amongst Aircraft ..... 53
3.2.1 Configurations ..... 53
3.2.2 Interactions ..... 53
3.2.3 Problem Cases Where ACM is on One Aircraft and ACAS is on the Other ..... 54

MEMBERSHIP ..... 57

## APPENDICES

Appendix A – SAMPLE OPERATIONAL SCENARIOS
A.1 Free Flight Scenario ..... A-1
A.2 Low Cost ACM Scenario ..... A-4
A.2.1 Introduction ..... A-4
A.2.2 Equipment ..... A-4
A.2.3 Operation ..... A-4
A.2.4 Example Flight Interaction ..... A-5
A.2.5 Additional Example Annunciation ..... A-6

Appendix B – REFERENCES

Appendix C – ABBREVIATIONS

Appendix D – DEFINITIONS

Appendix E – AIRBORNE EQUIPAGE IN A FREE FLIGHT ENVIRONMENT
Aircraft Equipage Categories ..... E-2
Unequipped Aircraft ..... E-2
Basic Equipped Aircraft ..... E-2
Dependent Aircraft ..... E-2
3-D-Dependent Aircraft ..... E-2
4-D-Dependent Aircraft ..... E-2
Independent Equipped Aircraft ..... E-2
3-D-Independent Aircraft ..... E-2
4-D-Independent Aircraft ..... E-3
Equipage and Capability Summary ..... E-3

Appendix F – PARALLEL WORK THAT MAY IMPACT FUTURE AIRSPACE OPERATIONS
Scope of DAG-TM Concept ..... F-1
ACM Related DAG-TM Concept Elements ..... F-1
Example: Concept Element 5 in Managed Airspace ..... F-2

Appendix G – ADS-B MESSAGE FORMAT

Appendix H – LIST OF UNRESOLVED ISSUES AND RESEARCH AREAS

## TABLE OF FIGURES


Figure 1-1 Conflict Probability Maps from Analytic Deterministic Analysis and Stochastic (Monte Carlo) Analysis....9
Figure 1-2 Example EUROCONTROL Simulator Navigation Display with a Conflict detected....10
Figure 1-3 NLR PASAS Example Display. ....11
Figure 1-4 Example NLR Conflict Resolution Display. ....12
Figure 1-5 Example EUROCONTROL Simulator Conflict Resolution. ....13
Figure 1-6 Separation Achieved in 8-Aircraft Conflicts a) Without and b) With Application of the Resolution Technique. ....14
Figure 1-7 Screenshot of Conflict Detection (moving map) ....15
Figure 2-1 ASSAP Functional View ....22
Figure 2-2 Example Cylindrical Zone Shapes for the Inner Collision Avoidance Zone (CAZ) and the Outer Protected Airspace Zone (PAZ)....23
Figure 2-3 Graphical Relationship Among Conflict Zones, Areas, and Thresholds, Viewed From Above ....29
Figure 2-4 Example PAZ and CAZ Zone Sizes, Depicted to Scale With a Large Aircraft....30
Figure 2-5 E xample PAZ and CAZ Zone Sizes, Different Scales. ....31
Figure 2-6 Effect of Slow Horizontal Closure Rate on Alert Thresholds ....32
Figure 2-7 Effect of Fast Horizontal Closure Rate on Alert Thresholds ....33
Figure 2-8 Effect of Slow Horizontal, Fast Vertical Closure Rates on Alert Thresholds....34
Figure 2-9 Effect of Fast Horizontal, Fast Vertical Closing Rates on Alert Thresholds ....35
Figure 2-10 Vertically Offset Intruder Aircraft....36
Figure 2-11 Horizontally Offset Intruder Aircraft....37
Figure 2-12 Intruder Outside of Alerting Parameters....38
Figure 2-13 Maneuver by Intruder Shifts Alerting Parameters....39
Figure 2-14 More Severe Maneuver Further Shifts Alerting Parameters. ....40
Figure 2-15 Low Level Alert, PAZ Alert Coming Soon....45
Figure 2-16 PAZ Alert. ....46
Figure 2-17 Conflict Resolved by Speed Change. ....47
Figure F-1 Flight Crew and Controller Temporal Zones .... F-3


## TABLE OF TABLES


Table 1-1 U. S. Runway Incursion Data [25]....5
Table 3-1 Conflict Resolution System Priority Matrix....54
Table E-1 Functional Category Summary.... E-1
Table E-2 Aircraft Equipage Summary.... E-4
Table F-1 Overview of ACM Concept Elements.... F-2
Table G-1 Information Requirements (R) or no Requirement (n/R) for ADS-B [4]....G-1

# 1 PURPOSE AND SCOPE

*Note:* *Aspects of this concept are still under development and have not yet been validated. The document is not intended to set requirements, but is intended to serve as a foundation for follow-on requirements development.*

## 1.1 Introduction

This document presents an operational concept for the Application of Airborne Conflict Management (ACM) using Automatic Dependent Surveillance-Broadcast (ADS-B). The ACM concept includes detecting conflicts, monitoring for potential conflicts, and suggesting resolutions to prevent a violation of airspace separation criteria against all other properly equipped aircraft/vehicles. (This concept was formerly known as Conflict Detection and Resolution [CD&R].)(See Appendix D for definitions.)

ACM is a core enabling function for the global implementation of the *Free Flight* concept, as it will aid pilots to fly user-preferred trajectories while avoiding conflicts with other aircraft. The long surveillance range afforded by ADS-B will enable alerts to be issued in time to solve the conflicts with minimum disruption to flight path. It is expected that the time provided by this long range will allow for a variety of solutions, or optimized solutions, thus enabling the choice of user-preferred trajectories while avoiding conflicts with other aircraft.

ACM includes three different functions: Conflict Detection (CD), Conflict Prevention (CP), and Conflict Resolution (CR). These functions need not all be present in an ACM system.

The CD part of this application will provide automated alerting and relevant traffic information, if displayed, to help the pilot detect existing conflicts with other aircraft based on current flight states and intents. The actions in response to these alerts may have to be coordinated with the air traffic service provider or may be solely managed by the pilot, depending on the operating environment and flight rules in effect at the time of the encounter.

The CP part of this application will predict conflicts that may occur if current flight state or own ship intent is changed. As such, it will offer guidance cues to prevent changes that will lead to conflicts.

The CR part of this application will provide recommended conflict resolutions or guidance cues. The CR function is designed to be completely interoperable with and functionally independent of existing Airborne Collision Avoidance Systems (ACAS).

Under normal circumstances, conflicts are expected to be resolved at long range by minor changes to the flight path. However, ACM is also designed with two shorter-range alert thresholds in which increasingly urgent alerts and updated resolutions are provided as necessary for required avoidance maneuvers.

In the future, it will be desirable for an ACM system to also take into account known, non-aircraft "threats" (e.g., terrain, weather, and restricted airspace); however, such capabilities are not described in this document.

This concept is being developed by a subgroup of Working Group 1 (WG-1) of RTCA Special Committee 186 (SC-186) on ADS-B. The group includes representatives from

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the aviation industry, the European Organization for the Safety of Air Navigation (EUROCONTROL), the Federal Aviation Administration (FAA), the National Aeronautics and Space Administration (NASA), and aviation analysis/research organizations. The objective of this work is to achieve a globally harmonized ACM system, including the interoperability of future U.S. and European civil aviation systems and operations.

This document is divided into three major sections. Section 1, Purpose and Scope, contains background, operational purpose and justification, intended airspace domains, and maturity and user interest. Section 2, ACM Concept, covers a description of the concept to include conflict zones, conflict detection, conflict prevention, conflict resolution, airspace operations, and pilot and controller responsibilities. Section 3, ACM/ ACAS/ADS-B Interoperability describes problems and solutions to the interoperability of these various systems. Additional information on the ACM concept, such as operational scenarios and how ACM may fits into various Free Flight concepts, is included in the appendices. Appendix H contains a list of unresolved issues and research areas.

## 1.2 Background

The FAA's strategic goals include airspace accessibility, flexibility, and predictability for the user community, which includes air carriers, air taxis, general aviation, and military users, while maintaining or improving safety. The *Free Flight* operational concept addresses these strategic goals and strongly emphasizes increased safety, user flexibility, operating efficiencies, and system capacity to meet the growing demands of the aviation industry. These goals are consistent with a number of European *Free Flight*, safety and capacity initiatives.

RTCA Task Force 3 refined the *Free Flight* concept during 1994 and 1995, describing it in detail in *The Final Report of RTCA Task Force 3: Free Flight Implementation* [7]. This October 1995 report defined the *Free Flight* operational concept, evaluated its architecture and technology needs, and identified an incremental plan for an evolutionary transition to the *Free Flight* "end-state." The RTCA Task Force 3 report also outlined specific operational capabilities and potential procedures and technologies that could achieve these concepts. Defined in the report was a future concept markedly different from today's largely procedural ground-based airspace management system enabled by limited air traffic decision support tools.

The International Civil Aviation Organization (ICAO) Secondary Surveillance Radar Improvements and Collision Avoidance Systems (SICAS) Panel Airborne Separation Assurance System (ASAS) subgroup has drafted an ASAS Circular [31]. This Circular provides a high level overview and concept of the ASAS, and identifies the main ASAS issues. It assumes that part of ASAS will be an airborne CD&R function. It also expects that Standards and Recommended Practices (SARPs) for CD&R will be required. The present ACM document can be the basis for those SARPs.

This new concept envisions a flexible collaborative decision-making system to be achieved by applying today's emerging Communications, Navigation, and Surveillance (CNS) and Air Traffic Management (ATM) technologies. The FAA further outlined this approach in the document, A *Concept of Operations for the National Airspace System in 2005* [1], first published in June 1997.

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Several significant CNS technological advances have occurred that now makes possible the *Free Flight* vision. For example, the advent of highly accurate, satellite-based position and time information (e.g., through use of a Global Navigation Satellite System (GNSS)), the development of digital data-links that allow rapid and reliable communications, and the emerging display and automation capabilities of existing aircraft and air traffic control facilities—all offer many of the capabilities needed to support *Free Flight* implementation.

Coupling advanced data communications technology with highly accurate, satellite-based position and time information opens rich opportunities to advance air and surface safety, reduce controller workload, increase capacity, enhance efficiency, improve productivity, and diminish environmental load. The synergy of these technologies has also created a new means of traffic surveillance—ADS-B. ADS-B is identified in the RTCA Task Force 3 *Free Flight* implementation as one of the key enabling technologies that makes this future ATM vision possible. To this end, the FAA has already incorporated ADS-B into the Air Traffic Services (ATS) Concept of Operations for the National Airspace System (NAS) and the NAS Architecture.

Functionally, ADS-B technology automatically broadcasts selected aircraft information such as identification, horizontal position, velocity, and altitude. These broadcasts are then received and used by other suitably equipped aircraft and ground stations to provide services, functions, and capabilities, based upon user/operator needs and requirements. Although ADS-B is an underlying assumption for the ACM system envisioned in this document, other surveillance systems may have the capability to provide data that meet the minimum requirements for ACM. Analysis is required to determine to what level other surveillance sources may be sufficient for ACM.

In Europe, as in the United States, air traffic is projected to increase significantly. For example, EUROCONTROL projects that air traffic will more than double in the European Civil Aviation Conference (ECAC) region by 2015 from 1998's level. Some parts of the airspace in Europe are already congested and cannot absorb even today's levels of demand at busy times [22].

The overall European aviation community objectives can be summarized as follows:

- Maintain and, where possible, enhance safety in future traffic growth
- Increase capacity to match future growth in air traffic demand
- Allow maximum freedom of movement to airspace users
- Provide a high degree of flexibility for flight operations
- Reduce environmental load

The overriding need is to generate higher system capacity in the busiest traffic areas while increasing safety.

In response to these needs, the European aviation community has embarked upon a number of research and development (R&D) projects to analyze emerging technologies and to evaluate new procedures. One recent R&D project is the multi-phased Free-Route Experimental Encounter Resolution (FREER) activity [11]. FREER was started in 1996 by the EUROCONTROL Experimental Centre and is currently in progress. FREER has a number of important objectives including development of an airborne separation

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