



WORKING PAPER

TWELFTH AIR NAVIGATION CONFERENCE

Montréal, 19 to 30 November 2012

Agenda Item 4: Optimum Capacity and Efficiency – through global collaborative ATM
4.1: Efficient management of airspace and improved flow performance through collaborative decision-making (CDM)

**AVIATION SYSTEM BLOCK UPGRADE MODULES
RELATING TO AIRBORNE SEPARATION**

(Presented by the Secretariat)

EXECUTIVE SUMMARY

The 37th Session of the ICAO Assembly directed ICAO to increase its efforts to meet global needs for airspace interoperability while maintaining its focus on safety. To this end, a planning framework for global harmonization and interoperability named the aviation system block upgrades (ASBU) is proposed to the Conference for incorporation into the Fourth Edition of the *Global Air Navigation Plan*.

The ASBU framework includes modules over a series of blocks, supported by technology roadmaps, which serve to progressively enhance many aspects of civil aviation operations. This paper presents the modules relating to ADS-B/MLAT ground based surveillance, air traffic situational awareness, interval management and airborne separation, which comprise:

- a) B0-84 – Ground-based surveillance;
- b) B0-85, B1-85, B2-85 & B3-85 – Air traffic situational awareness and airborne separation applications; and
- c) B0-86 – Improved access to optimum flight levels.

Action: The Conference is invited to agree to the recommendation in paragraph 3.

<i>Strategic Objectives:</i>	This working paper relates to the Safety Strategic Objective.
<i>Financial implications:</i>	The cost impacts for some modules are expected to be substantial, and the aircraft operators concerned may need to undertake considerable investment. Investments in ground-based surveillance will be borne by air navigation service providers (ANSPs). However, based on preliminary indications, the benefits of implementing these modules could be substantial for individual aircraft operators and ANSPs as well as global system performance and, when implemented, the benefits are expected to far outweigh the costs.
<i>References:</i>	Doc 9958, <i>Assembly Resolutions in Force (as of 8 October 2010)</i> Doc 9854, <i>Global Air Traffic Management Operational Concept</i> Doc 9750, <i>Global Air Navigation Plan</i> AN-Conf/12-WP/3

1. INTRODUCTION

1.1 The next edition of the *Global Air Navigation Plan* (Doc 9750, GANP) will be presented to the next ICAO Assembly in 2013 for approval. The draft GANP, and the aviation system block upgrade (ASBU) strategy it establishes, proposes that future air navigation technology and procedure improvements are organized and based on a consultative strategic approach that coordinates specific global performance capabilities and the flexible upgrade timelines associated with each component.

1.2 The ASBU modules are organized into flexible and scalable building blocks that can be implemented depending on the operational need, while recognizing that implementation of a particular module is not mandatory in all areas or circumstances. The approach adopted is not limiting and recognizes that deployment in addition to the material described in the ASBUs may also take place or be necessary. The broad timescales associated with the ASBU framework (Block 0 = 2013, Block 1 = 2018, Block 2 = 2023, Block 3 = 2028) are intended only to depict the initial readiness of all components, including ICAO Standards and Recommended Practices (SARPs), needed for deployment and do not imply a mandated State or regional implementation timeframe. The ASBU framework with supporting technology roadmaps ensures that State and regional implementation planning and deployment activities can be undertaken with the confidence that all components necessary for a particular deployment will be available within the ASBU dates mentioned.

1.3 Traffic congestion provides a constant challenge and has led to a number of initiatives, such as reduced vertical and horizontal separation minima, aimed at increasing the number of aircraft in the same volume of airspace. Implementation of ground-based technology tools that result in improved situational awareness by air traffic control (ATC) facilitate the closer packing of aircraft. Similarly, airborne technologies that increase crew situational awareness facilitate development of procedures that delegate some additional responsibilities for separation to crew members. To take increasing advantage of current ground based surveillance technologies and the fast evolving airborne technologies enhancing crew trajectory management and situational awareness, three significant planning threads, as described in the appendices to this paper and illustrated in the attached Figure 1, are proposed for inclusion in the ASBU framework:

- a) ground-based surveillance;
- b) air traffic situational awareness (ATSA), interval management (IM) and airborne separation applications; and
- c) improved access to optimum flight levels.

2. OPTIMUM CAPACITY AND EFFICIENCY

Overall strategy

2.1 Continued pursuit of methodologies to increase airspace capacity is necessary to alleviate airspace congestion. From the ground, airspace surveillance capabilities allow ATC access to additional tools and procedures to safely increase aircraft proximity. Developments in ADS-B OUT and multilateration (MLAT) technology make available lower cost, high reliability alternatives to the primary and secondary radar systems that previously formed the core of ATC surveillance networks. Recent operational deployments of ADS-B OUT and MLAT have demonstrated the available performance and benefits, such that these technologies are expected to be cost effective when making infrastructure decisions for airspaces currently without surveillance capabilities.

2.2 In the air, increased airspace capacity results from highly accurate aircraft performance in all dimensions of navigation, including time. Interval management takes advantage of automated ground tools to assist the air traffic controller in determining appropriate clearances to merge and space aircraft efficiently, in conjunction with airborne tools that ensure that flight crew can accurately conform to the time or distance interval specified by ATC. Over time, and supported by data com technologies, the availability of on-board air traffic situational awareness (ATSA) tools will enable increasing responsibility to be placed on flight crews for interval management and its evolution to airborne separation. In the interim, individual ATSA applications are under development, with in-trail procedures (ITP) using ADS-B IN already being trialled. ITP will provide aircraft access to optimum flight levels in oceanic airspace to alleviate situations where traffic is otherwise limited to non optimal flight levels by the large separation standards required.

Incremental development

2.3 With Block 0, the provision of ground surveillance capability can be achieved for lower cost by using technologies such as ADS-B OUT and MLAT systems. Cockpit equipment supporting ADS-B IN will display surrounding traffic equipped with ADS-B OUT, assisting crews to visually acquire traffic of interest. Some delegation of separation responsibilities by ATC to the flight crew using visual separation clearances could then be given, to optimize an approach sequence, for example. Application of ADS-B ITP enables an aircraft to climb or descend through the level of other aircraft when the air traffic controllers' requirements for procedural separation cannot be met.

2.4 Block 1 introduces advanced avionics functions that, with controller-pilot data link communications (CPDLC), allow deployment of new procedures where the flight crew use airborne equipment to establish and maintain a given time or distance from the target aircraft – termed interval management. Rather than applying speed control and/or radar vectors, the air traffic controllers retains separation responsibility but uses interval management techniques for improved control of aircraft spacing and traffic flows.

2.5 In the Block 2 timeframe, cooperative separation between ATC and aircraft is envisaged. Under air traffic controllers' instructions, flight crews take delegated responsibility for separation from proximate aircraft specified by the air traffic controller to relieve the controller from responsibility for separation between these aircraft. The air traffic controller retains separation responsibility for all surrounding aircraft that are not part of the cooperative separation clearance. Treatment of aircraft pairs using in-trail follow and/or in-trail merge procedures will comprise the initial applications of cooperative separation.

2.6 The Block 3 timeframe looks toward an airborne self separation environment, whereby the flight crew, using advanced airborne systems, hold full responsibility for the separation of their aircraft from all surrounding traffic. It is expected that the early applications of airborne separation will take place in low density airspace and with support from ATSA applications and data link technologies. If additional benefits can be derived procedures will evolve from IM methods in which the air traffic controller and crew are involved, through airborne spacing, then delegated separation and finally self separation under the responsibility of the flight deck.

Technology requirements

2.7 These operational improvements are heavily reliant on technology support. Ground-based surveillance can evolve to ADS-B OUT and/or MLAT technology. Sharing of trajectory information requires automated ATM systems. In the air, ADS-B OUT initially, then ADS-B IN capabilities are key components, with support from CPDLC. The precision and richness of information from ADS-B

versions 2 and 3 will drive the performance of Interval Management procedures. Cockpit systems must provide sufficient functionality for flight crew to be able to assume increasing levels of air traffic controller delegated responsibility for separation.

Deployment considerations

2.8 In terms of ICAO provisions, development of the *Airborne Surveillance Manual* (Doc 9924) is advanced and necessary updates to ICAO SARPS and manuals have been identified. Additional CPDLC messages will be necessary to support IM. Subsequently, appropriate reduced separation minima and procedures will be necessary to obtain the full benefits of increased airspace capacity. Development and validation of operating concepts for airborne separation and self separation will be necessary to provide a framework for these developments.

2.9 Careful consideration will be necessary to accurately specify the accountabilities and responsibilities of each operational party. The Human Factors considerations are extensive in ensuring that both flight crew and air traffic controllers are adequately prepared to take on the changing real-time responsibilities of which party holds separation responsibility at any given time or for any given situation.

2.10 Deployment challenges will arise in terms of managing operations in a mixed equipage environment, and in complex or high traffic density areas. As such, homogenous aircraft equipage will be necessary to deliver aviation system benefits in more densely trafficked areas. The common ADS-B OUT component suggests that large scale implementations should be pursued, recognising that implementation of differing versions of ADS-B at different times and in different parts of the globe will benefit from backwards compatibility between versions.

2.11 Interval management techniques are applicable in most airspace and should bring substantial improvement in low density, oceanic or remote areas in allowing reduced separation without the need for large investments in surveillance infrastructure.

2.12 States and operators are urged to give due consideration to the potential added benefits which could result from the integration of a number of modules across a number of threads. Aspects of the integration of several supporting systems at an early stage may generate additional benefits downstream (i.e. Blocks 2 and/or 3). Benefits from an integrated implementation of all modules are expected to be greater than the sum of all benefits attributable to individual modules.

3. CONCLUSION

3.1 The ASBUs describe ways to apply the concepts defined in the *Global Air Traffic Management Operational Concept* (Doc 9854) to achieve local and regional performance improvements. The ultimate goal is global interoperability. Safety and efficiency demands this level of interoperability and harmonization which must be achieved at a reasonable cost with commensurate benefits. The Conference is invited to agree to the following recommendation:

Recommendation 4/x - ICAO aviation system block upgrades (ASBUs) relating to ground surveillance using automatic dependent surveillance – broadcast/multilateraion (ADS-B/MLAT), air traffic situational awareness (ATSA), interval management and airborne separation

That the Conference:

- a) urge States, according to their operational needs, to implement the aviation system block upgrade modules relating to ground surveillance, improved air traffic situational awareness and improved access to optimum flight levels included in Block 0, as presented in Appendices A through C;
- b) endorse the aviation system block upgrade modules relating to interval management included in Block 1, as presented in Appendix D, and recommend that ICAO use it as the basis of its work programme on the subject;
- c) endorse the aviation system block upgrade modules relating to airborne separation included in Blocks 2 and 3, as presented in Appendices E and F, as the strategic direction for this subject; and
- d) request ICAO to include, following further development and editorial review, the aviation system block upgrade modules relating to airborne separation in the draft Fourth Edition of the *Global Air Navigation Plan*.

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Figure 1. Block upgrade modules covered in this working paper

