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WORKING PAPER

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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 RELATED TO AIRBORNE COLLISION AVOIDANCE SYSTEMS AND GROUND-BASED SAFETY NETS

(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 airborne collision avoidance systems and ground-based safety nets which comprise:

a) B0-101 & B2-101 – Airborne collision avoidance system (ACAS) improvements; and

b) B0-102 & B1-102 – Ground-based safety nets.

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

Strategic Objectives:	This working paper relates to the Safety Strategic Objective.
Financial implications:	The cost impact for some modules is expected to be substantial, and the aircraft operators concerned may need to undertake considerable investment. Costs also exist for air navigation service providers (ANSPs) and will vary depending on the ability to configure existing air traffic management (ATM) automation. However, based on preliminary indications, the benefits and increase of safety of implementing these modules could be substantial for individual aircraft operators and overall global system performance and, when implemented, the benefits are expected to far outweigh the costs.
References:	Doc 9958, *Assembly Resolutions in Force (as of 8 October 2010)* Doc 9854, *Global Air Traffic Management Operational Concept* Doc 9750, *Global Air Navigation Plan* 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 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 Two planning threads, one each for airborne and ground safety nets as described in the appendices to this paper and illustrated in the attached Figure 1, is proposed for inclusion in the ASBU framework.

2. AIRBORNE COLLISION AVOIDANCE SYSTEMS (ACAS) AND GROUND-BASED SAFETY NETS

2.1 Safety nets monitor aspects of the operational environment and generate an alert if a safety risk exists or remedial action is necessary to assure flight safety. They comprise:

a) those installed in the aircraft for use by flight crew and/or the aircraft itself, for example an airborne collision avoidance system (ACAS); and

b) those deployed in ground-based systems, such as used by air traffic controllers, for example short term conflict alert (STCA), minimum safe altitude warning (MSAW).

Overall strategy

2.2 Collision avoidance systems, whether airborne or on the ground, have to be capable of adapting to the operational environment (i.e. traffic types and densities, changes in airspace configuration and operational procedures) but foremost must be reliable. While safety nets contribute to safety, the generation of false or nuisance alerts has to be minimized or preferably avoided. Accordingly, future iterations should be able to accommodate, for example, a variety of reduced separation minima and new procedures (such as 4D trajectory operations), as well as operational challenges such as those represented by new vehicles including remotely piloted aircraft (RPA). Deployment of evolutionary more ‘intelligent’ ACAS in the air and the wide implementation of conflict alert, area proximity warnings and minimum safe altitude warning systems on the ground will be strengthened by the inclusion of approach path monitoring systems for controlled flight into terrain (CFIT) alerting and adaptation of existing functions to the new 4D trajectory environment.

Incremental development

2.3 In the aircraft and available in Block 0, traffic alert and collision avoidance system (TCAS), Version 7.1 has enhanced protection and functionality through inclusion of the monitoring of "own aircraft's" vertical rate and improved Resolution Advisory (RA) annunciation. Protection and performance is enhanced further by a new altitude capture law (that addresses cleared level overshoot effect) and by including optional features such as coupling of the ACAS with the auto-pilot/flight director to ensure accurate responses to RAs.

2.4 On the ground, safety net equipment includes programmable air traffic management (ATM) systems with alerting capabilities. Short-term conflict alert (STCA) is intended to alert the air traffic controller to a potential or actual infringement of separation minima. Area proximity warnings (APW) alert air traffic controllers about imminent penetration of a protected airspace volume. Minimum safe altitude warning (MSAW) will alert the air traffic controller about proximity to terrain.

2.5 From Block 1, the ground safety net functions are expected to be augmented by deployment of an approach path monitor (APM) capability to notify the air traffic controllers of a system-perceived risk of a controlled flight into terrain during final approach.

2.6 With Block 2, the evolution of ACAS is expected to address the limitations of current technology and will accurately discriminate between necessary alerts and nuisance alerts across the reduced horizontal and vertical separation minima projected for future procedures. Additionally, this generation of ACAS should be configurable for new procedures and air vehicles, such as 4D trajectory operations and RPA, respectively.

Technology requirements

2.7 Enhancements to airborne and ground safety nets are clearly technology based and will depend upon the evolution and development of surveillance and system processing capabilities. The need to serve 4D trajectory operations and accommodate trajectory conformance monitoring in all dimensions should provide the impetus to redefine safety net algorithms to fit future operations. Technology requirements and the linkages between the various Blocks and modules of the ASBU framework are detailed in the technology roadmaps that constitute part of the draft Fourth Edition of the *Global Air Navigation Plan* (GANP) (AN-Conf/12-WP/3 refers).

Deployment considerations

2.8 By their nature, safety nets are designed specifically for and implemented in particular airframes and ATC centres, therefore interoperability is essential. Hence, the development of safety nets, including the derivation of algorithms and operational procedures, should be harmonized globally. Equally, an awareness and mitigation of common failure modes (e.g. baro-altimeter) is necessary. Deployment of airborne safety nets could benefit from widespread implementation of ABS-B, with backwards compatibility between the ADS-B versions. Developments in ATM automation should build in capability for the various system alerts and flexibility in their local programming to fit particular site considerations.

2.9 Recognising that current ICAO provisions for ACAS installation are actually partly recommended practices, future safety net deployment should include consideration of upgrading these to Standards.

2.10 Safety nets are designed to serve as a last line of defence and are not intended to replace conventional systems, such as for surveillance. In this context, it is arguable whether the use of safety nets should be included in safety performance assessments and calculations for target level of safety, or if, because they should not be triggered, they should not be considered a valid contribution to the safety of routine operations for assessment purposes. ICAO provisions may be necessary to address these questions.

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 demand 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 airborne collision avoidance systems and ground-based safety nets

That the Conference:

a) urge States, according to their operational needs, to implement the aviation system block upgrade modules relating to airborne collision avoidance systems and ground-based safety nets included in Block 0 , as presented in Appendices A and B;

b) endorse the aviation system block upgrade module relating to ground-based safety nets included in Block 1, as presented in Appendix C, and recommend that ICAO use it as the basis of its work programme on the subject;

c) endorse the aviation system block upgrade module relating to airborne collision avoidance systems included in Block 2, as presented in Appendix D, as the strategic direction for this subject; and

d) request ICAO to include, following further development and editorial review, the ASBU modules relating to airborne collision avoidance systems and ground-based safety nets 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