



WORKING PAPER

TWELFTH AIR NAVIGATION CONFERENCE

Montréal, 19 to 30 November 2012

Agenda Item 3: Interoperability and data – through globally interoperable system-wide information management (SWIM)

3.3: Service improvement through digital AIM

**AVIATION SYSTEM BLOCK UPGRADE MODULES RELATING TO
SERVICE IMPROVEMENT THROUGH DIGITAL AIM AND ATM INFORMATION**

(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 service improvement through digital aeronautical information management (AIM) and the integration of digital air traffic management (ATM) information, which comprise:

- a) B0-30 and B1-30 – Integration of aeronautical and ATM information.

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 impact for these modules is expected to be minimal, and is anticipated to be borne predominantly by States. However, based on preliminary indications, the benefits of implementing these modules could be substantial for 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 recognises 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 (SARP), 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 A planning thread describing the phased deployment of modules delivering service improvements through digital aeronautical information management (AIM) as well as the integration of digital air traffic management (ATM) information, as described in the appendices to this paper and illustrated in the attached Figure 1, is proposed for inclusion in the ASBU framework.

2. DIGITAL AIM AND INTEGRATED ATM

Overall strategy

2.1 The Eleventh Air Navigation Conference (2003) recommended the urgent adoption of a common aeronautical exchange model which took into account operational systems and concepts of data interchange, including specifically aeronautical information conceptual model/aeronautical information exchange model (AICM/AIXM), and addressed their mutual interoperability. Consequently, the move from aeronautical information service (AIS) to aeronautical information management (AIM), and from paper to electronic media, is already well supported by standardized formats based on widely used information technology standards (UML, XML/GML) operating on commonplace technology products and electronic storage.

2.2 The deployment of an ATM information reference model (AIRM) capturing all the types of information used by ATM in a consistent set of data and service models (using UML, GML/XML) that can be accessed via internet protocol based tools will extend this evolution from strictly AIM and AIXM, to full integration of all digital ATM information. This next phase of digital information management requires the development of exchange data models for meteorological information (WXXM), flight and flow information (FIXM) and aircraft performance related data. The steps along this path call for interoperability via global agreement on the various formats and protocols required to enable the provision of digital ATM information.

Incremental development

2.3 As the desired end state, (Block 3 timeframe) all ATM information should be fully digitally managed using an ATM information reference model comprising at least AIXM for aeronautical information, WXXM for weather information and FIXM for flight information, as well as other components found necessary over time. All these components and their associated services and applications will be fully integrated in system-wide information management (SWIM). The various formats and related applications will have been defined with interoperability as a cornerstone and in a manner that enables ready extensibility. These foundation requirements should be agreed early and deployed at the Block 1 stage to provide the stable platform necessary to build on. Formats, information models and data structures should remain sufficiently open in order to allow further evolution in line with full 4D trajectory applications.

2.4 At the first stage (Block 0), ATM information is limited to aeronautical information with standardized formats based on UML and XML/GML information technology standards. Information quality is increased, and efficiencies are gained in the general management of aeronautical information and specifically the management of digital NOTAMs. The Block 1 timeframe sees the deployment of the AIRM and associated WXXM for weather information and FIXM for flight information, in addition to the existing AIXM for AIM information. Additional capabilities thus enabled are the management, distribution and processing of weather data, flight and flow data and aircraft performance data as the initial transition to an integrated digital ATM information operating environment.

Technology requirements

2.5 The integrated ATM information environment utilises evolving industry standard IT technology. These applications will form integral components of SWIM and the technology relationships for AIRM will be closely linked with the technology requirements for SWIM. The far greater reliance on IT in these increasingly integrated applications is expected to drive future needs for a common technology for ground systems. Technology requirements, including the Information Management Roadmap, 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

2.6 As a result of the existing deployments enabling digital AIM, the quality and overall management of aeronautical information has been enhanced; the continuation of these initiatives is essential. To move forward into the wider ATM information context, the global agreement on, and development and validation of, the AIRM and associated formats (WXXM, FIXM etc) and related applications is fundamental. Existing processes and procedures for data management in ATM are expected to need upgrading and broadening. The need to ensure complete end state access to the full data richness of SWIM must be kept in view throughout these developments, with concurrent need to ensure all databases, including airborne data bases are kept accurate and up to date. Software development and IT maturity of ground systems will need to keep pace.

2.7 Some benefits from AIRM can result from localized implementations; however the true benefits will result from very widespread deployment that enables the global exchange of information. In this regard, global agreements on many aspects remain critically important and the question of regional or global mandates of the formats will need to be addressed in the near-term.

2.8 States and users 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:

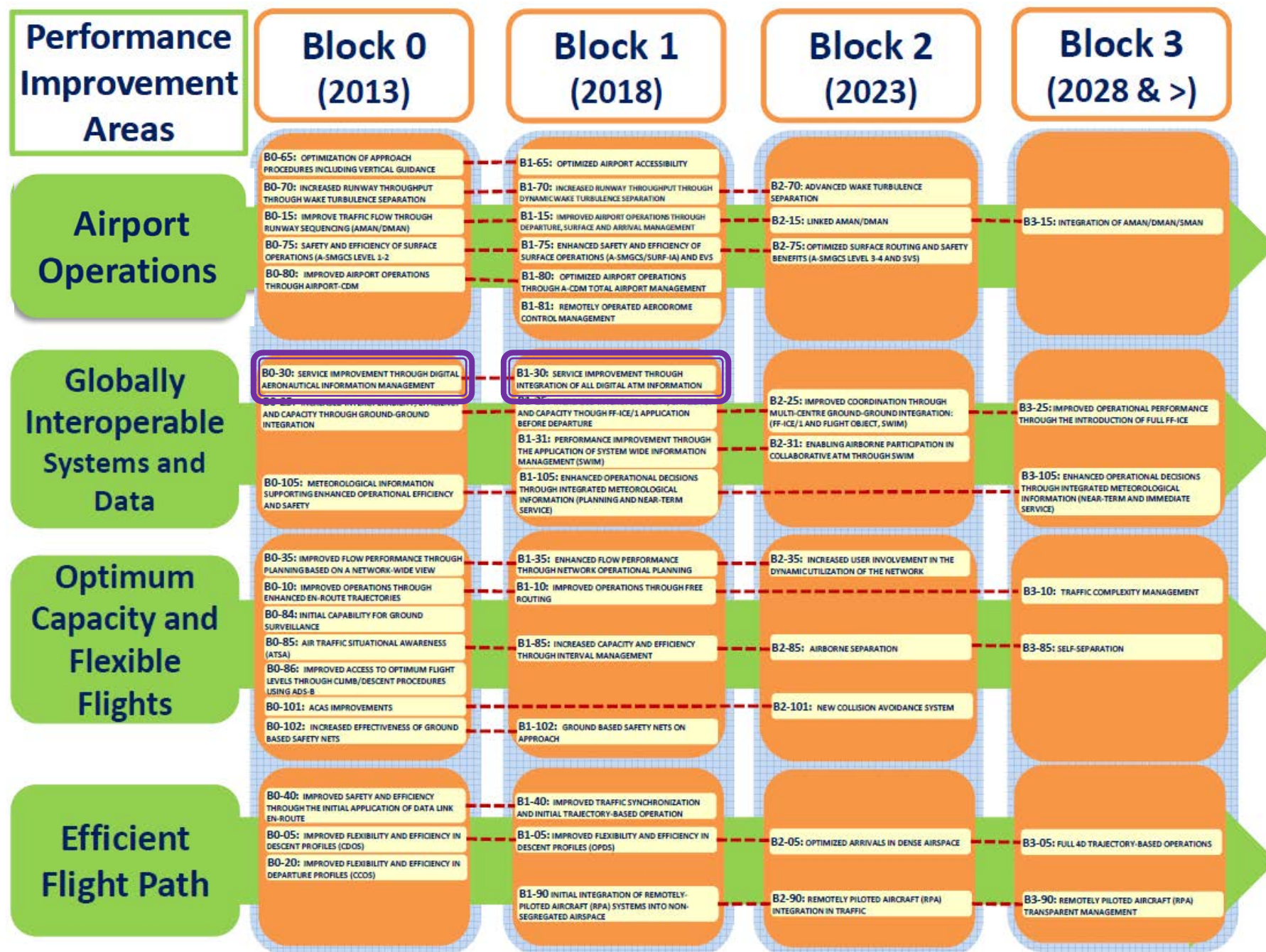
Recommendation 3/x - ICAO aviation system block upgrades (ASBUs) relating to service improvement through aeronautical information management as well as digital air traffic management (ATM) information

That the Conference:

- a) urge States, according to their operational needs, to implement the aviation system block upgrade module relating to service improvement through digital aeronautical information management included in Block 0, as presented in Appendix A;
- b) endorse the aviation system block upgrade module relating to service improvement through the integration of digital air traffic management information included in Block 1, as presented in Appendix B, and recommend that ICAO use it as the basis of its work programme on the subject; and
- c) request ICAO to include, following further development and editorial review, the aviation system block upgrade modules relating to service improvement through digital aeronautical information management as well as integration of digital air traffic management information 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



APPENDIX A

**MODULE NO. B0-30: SERVICE IMPROVEMENT THROUGH DIGITAL
AERONAUTICAL INFORMATION MANAGEMENT**

Summary	The initial introduction of digital processing and management of information, through aeronautical information service (AIS)/aeronautical information management (AIM) implementation, use of aeronautical information exchange model (AIXM), migration to electronic aeronautical information publication (AIP) and better quality and availability of data.	
Main performance impact as per Doc 9854	KPA-03 – Cost-effectiveness, KPA-05 – Environment, KPA-07 – Global interoperability, KPA-10 – Safety.	
Operating environment/ Phases of flight	All phases of flight	
Applicability considerations	Applicable at State level, with increased benefits as more States participate	
Global concept component(s) as per Doc 9854	IM – information management	
Global plan initiatives (GPI)	GPI-18: Electronic information services	
Main dependencies	NIL	
Global readiness checklist		Status (ready now or estimated date)
	Standards readiness	✓
	Avionics availability	✓
	Ground systems availability	✓
	Procedures available	✓
	Operations approvals	✓

1. NARRATIVE

1.1 General

1.1.1 The subject has been discussed at the Eleventh Air Navigation Conference (Doc 9828, AN-Conf/11) which made the following recommendation:

Recommendation 1/8 — Global aeronautical information management and data exchange model

That ICAO:

- a) when developing ATM requirements, define corresponding requirements for safe and efficient global aeronautical information management that would support a digital, real-time, accredited and secure aeronautical information environment;
- b) urgently adopt a common aeronautical information exchange model, taking into account operational systems or concepts of data interchange, including specifically, aeronautical information conceptual model/aeronautical information exchange model, and their mutual interoperability; and

- c) develop as a matter of urgency, new specifications for Annex 4 — *Aeronautical Charts* and Annex 15 — *Aeronautical Information Services* that would govern provision, electronic storage, on-line access to and maintenance of aeronautical information and charts.

1.1.2 The long-term objective is the establishment of a network-centric information environment, also known as system-wide information management (SWIM).

1.1.3 In the short- to medium-term, the focus is on the continuing transition of the services provided by aeronautical information services (AIS) from a product-centred, paper-based and manually-transacted focus to a digitally-enabled, network-centred and service-oriented aeronautical information management (AIM) focus. AIM envisages a migration to a data centric environment where aeronautical data will be provided in a digital form and in a managed way. This can be regarded as the first step of SWIM implementation, which is based on common data models and data exchange formats. The next (long-term) SWIM step implies the re-thinking of the data services in terms of a “network” perspective.

1.1.4 AIS must transition to a broader concept of AIM, with a different method of information provision and management given its data-centric nature as opposed to the product-centric nature of traditional AIS provision.

1.1.5 The expectations are that the transition to AIM will not involve many changes in terms of the scope of information to be distributed. The major change will be the increased emphasis on data distribution, which should place the future AIM in a position to better serve airspace users and air traffic management (ATM) in terms of their information management requirements.

1.1.6 This first step towards SWIM is easy to make because it concerns information that is static or does not change often, yet it generates substantial benefits even for small States. It allows for initial experience to be gained before making further steps towards full-SWIM implementation.

1.2 **Baseline**

1.2.1 The baseline is the traditional provision of aeronautical information, based on paper publications and NOTAMs.

1.2.2 AIS information provided by ICAO Member States has traditionally been based on paper documents and text messages (NOTAM) and maintained and distributed as such. In spite of manual verifications, this did not always prevent errors or inconsistencies. In addition, the information had to be transcribed from paper to automated ground and airborne systems, thus introducing additional risks. Finally, the timeliness and quality of required information updates could not always be guaranteed.

1.3 **Change brought by the module**

1.3.1 The module continues the transition of AIS from traditional product provision to a digitally enabled service oriented environment with information exchange utilizing standardized formats based on widely used information technology standards (UML, XML/GML). This will be supported by industrial products and stored on electronics devices. Information quality is increased, as well as that of the management of aeronautical information in general. The AIP moves from paper to electronic support.

2. INTENDED PERFORMANCE OPERATIONAL IMPROVEMENT

2.1 Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

<i>Cost Effectiveness</i>	Reduced costs in terms of data inputs and checks, paper and post, especially when considering the overall data chain, from originators, through AIS to the end users.
<i>Environment</i>	Reducing the time necessary to promulgate information concerning airspace status will allow for more effective airspace utilization and allow improvements in trajectory management.
<i>Global Interoperability</i>	Essential contribution to interoperability.
<i>Safety</i>	Reduction in the number of possible inconsistencies. Module allows reducing the number of manual entries and ensures consistency among data through automatic data checking based on commonly agreed business rules.
<i>Cost Benefit Analysis</i>	The business case for the aeronautical information conceptual model (AIXM) has been conducted in Europe and in the United States and has shown to be positive. The initial investment necessary for the provision of digital AIS data may be reduced through regional cooperation and it remains low compared with the cost of other ATM systems. The transition from paper products to digital data is a critical pre-requisite for the implementation of any current or future ATM or air navigation concept that relies on the accuracy, integrity and timeliness of data.

3. NECESSARY PROCEDURES (AIR AND GROUND)

3.1 No new procedures for air traffic control are required, but the process for AIS needs to be revisited. To obtain the full benefit, new procedures will be required for data users in order to retrieve the information digitally, for example, to allow airlines provide digital AIS data to on-board devices, in particular electronic flight bags (EFBs).

4. NECESSARY SYSTEM CAPABILITY

4.1 Avionics

4.1.1 No avionics requirements.

4.2 Ground systems

4.2.1 The aeronautical information is made available to AIS through digital processes and to external users via either a subscription to an electronic access or physical delivery; the electronic access can be based on Internet protocol services. The physical support does not need to be standardized. The main automation functions that need to be implemented to support provision of electronic AIS are the national aeronautical data, NOTAM (both national and international) and meteorological management including data collection, verification and distribution.

5. HUMAN PERFORMANCE

5.1 Human factors considerations

5.1.1 The automated assistance is well accepted and proven to reduce errors in manual transcription of data.

5.1.2 Human factors have been taken into consideration during the development of the processes and procedures associated with this module. Where automation is to be used, the human-machine interface has been considered from both a functional and ergonomic perspective. The possibility of latent failure however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues, identified during implementation, be reported to the international community through ICAO as part of any safety reporting initiative.

5.2 Training and qualification requirements

5.2.1 Training is required for AIS/AIM personnel.

6. REGULATORY/STANDARDIZATION NEEDS AND APPROVAL PLAN (AIR AND GROUND)

- Regulatory/standardization: use current published requirements that include material given in Section 8.
- Approval plans: to be determined, based upon regional applications.

7. IMPLEMENTATION AND DEMONSTRATION ACTIVITIES (AS KNOWN AT TIME OF WRITING)

7.1 Current use

- **Europe:** the European AIS Database (EAD) became operational in June 2003. Electronic AIP (eAIP) providing fully digital versions of the paper document based on a EUROCONTROL eAIP specification, have been implemented (on-line or on a CD) in a number of States including Armenia, Belgium and Luxembourg, Hungary, Jordan, Latvia, Moldova, Netherlands, Portugal, Slovak Republic, and Slovenia (for full and latest list of States operational with eAIP) see <http://www.eurocontrol.int/articles/electronic-aeronautical-information-publication-phase-2-p-11>, EAD and eAIP are essential milestones in the realization of the digital environment. The EAD was developed using the aeronautical information conceptual model (AICM) and aeronautical information exchange model (AIXM). Whilst some European States have chosen to use the EAD client system and software, others implement their own AIM solution instead and connect it to EAD in a system-to-system connection (e.g. France).
- **United States:** Digital NOTAM is currently deployed and in use in the United States using the AIXM 5.1.
- **Other regions:** Azerbaijan, Japan, and Jordan have implemented the eAIP.

- AIXM-based systems are in various stages of implementation in several countries around the world, including Australia, Brazil, Canada, Fiji, India, Panama, South Africa, Singapore, ASECNA, etc.

7.2 Planned or ongoing activities

7.2.1 The current trials in Europe and the United States focus on the introduction of Digital NOTAM, which can be automatically generated and used by computer systems and do not require extensive manual processing, as compared with the text NOTAM of today. More information is available on the EUROCONTROL and FAA websites:

http://www.EUROCONTROL.int/aim/public/standard_page/xnotam.html

<http://notams.aim.faa.gov/fnsstart/>

8. REFERENCE DOCUMENTS

8.1 Standards

8.1.1 Further changes to ICAO Annex 15 – *Aeronautical Information Services* are in preparation.

8.2 Procedures

8.2.1 In preparation.

8.3 Guidance material

- ICAO Doc 8126, *Aeronautical Information Services Manual*, including AIXM and eAIP as per Third Edition
- ICAO Doc 8697, *Aeronautical Chart Manual*
- *Roadmap for the Transition from AIS to AIM*
- Manuals on AIM quality system and AIM training.

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APPENDIX B

MODULE NO. B1-30: SERVICE IMPROVEMENT THROUGH INTEGRATION OF ALL DIGITAL ATM INFORMATION

Summary	To implement the ATM information reference model integrating all ATM information using common formats (UML/XML and WXXM) for meteorological information and FIXM for flight and flow information, and internet protocols.	
Main performance impact as per Doc 9854	KPA-01 – Access & Equity, KPA-03 – Cost-effectiveness, KPA-07 – Global Interoperability, KPA-10 – Safety, KPA-11 – Security.	
Operating environment/ Phases of flight	All phases of flight	
Applicability considerations	Applicable at State level, with increased benefits as more States participate	
Global concept component(s) as per Doc 9854	IM – information management	
Global plan initiatives (GPI)	GPI-18: Electronic information services	
Main dependencies	B0-30 Parallel progress with: B1-25, B1-31	
Global readiness checklist		Status (ready now or estimated date)
	Standards readiness	Est. 2018
	Avionics availability	NA
	Ground systems availability	Est. 2018
	Procedures available	✓
	Operations approvals	Est. 2018

1. NARRATIVE

1.1 General

1.1.1 The module captures two main actions which capitalize on the advances made in the previous block on the same subject. The module will implement the air traffic management information reference model (AIRM) capturing all the types of information used by ATM in a consistent set of data and service models (using UML, GML/XML) and that can be accessed via internet protocol-based tools. The module also implements a second step of digital information management with exchange data models; WXXM for meteorological information; FIXM for flight and flow information; and aircraft performance-related data. The further standardization of aircraft performance data is also to be considered.

1.2 Baseline

1.2.1 The baseline at the implementation level is the use of AIS data, resulting from Module B0-30. The AIXM, the WXXM, and FIXM models are compatible with the ATM information reference model (AIRM).

1.3 Change brought by the module

1.3.1 This module expands the approach pioneered by AIXM to the other forms of information by providing the overall reference model framework, allowing each type of data to fit into a harmonised structure, with the implementation of AIXM providing the foundation for data from other domains that are associated with AIM data. It also proceeds with the additional capability to manage, distribute and process the weather data, possibly flight and flow data and aircraft performance-related data. In addition to interoperable data, the module starts to provide interoperable information services as part of the transition to a service-oriented architecture.

2. INTENDED PERFORMANCE OPERATIONAL IMPROVEMENT

2.1 Metrics to determine the success of the module are proposed in the *Manual on Global Performance of the Air Navigation System* (Doc 9883).

<i>Access and Equity</i>	Greater and timelier access to up-to-date information by a wider set of users.
<i>Cost Effectiveness</i>	Reduced processing time for new information; increased ability of the system to create new applications through the availability of standardized data.
<i>Global Interoperability</i>	Essential for global interoperability.
<i>Safety</i>	Reduced probability of data errors or inconsistencies; reduced possibility to introduce additional errors through manual inputs.
<i>Security</i>	Information security considerations are embedded in the developments.
<i>Cost Benefit Analysis</i>	Business case to be established in the course of the projects defining the models and their possible implementation.

3. NECESSARY PROCEDURES (AIR AND GROUND)

3.1 No new procedures for ATM, but a revisited process for management of information.

4. NECESSARY SYSTEM CAPABILITY

4.1 Avionics

4.1.1 No avionics requirement.

4.2 Ground systems

4.2.1 All users and producers of the information will need to implement the ATM information reference model (AIRM) to support their exchanges with other members of the ATM community.

5. HUMAN PERFORMANCE

5.1 Human factors considerations

5.1.1 The use of a common model supported by the industrial IT tools will serve to reduce errors in manual transcription of data and in the management of information.

5.1.2 The identification of human factors considerations is an important enabler in identifying processes and procedures for this module. In particular, the human-machine interface for the automation aspects of this performance improvement will need to be considered and, where necessary, accompanied by risk mitigation strategies such as training, education and redundancy.

5.2 Training and qualification requirements

5.2.1 Training is required for personnel managing the ATM information and for their users if the interfaces and access conditions change.

5.2.2 Training in operational Standards and procedures will be identified along with the Standards and Recommended Practices necessary for this module to be implemented. Likewise, the qualifications requirements will be identified and included in the regulatory readiness aspects of this module when they become available.

6. REGULATORY/STANDARDIZATION NEEDS AND APPROVAL PLAN (AIR AND GROUND)

- Regulatory/standardization: new Standards and guidance needed to address information formatting and templates including that given in Section 8.4.
- Approval plans: to be determined.

7. IMPLEMENTATION AND DEMONSTRATION ACTIVITIES (AS KNOWN AT TIME OF WRITING)

7.1 Current use

7.1.1 None identified.

7.2 Planned or ongoing activities

- **SESAR:** SESAR is currently defining and validating the ATM information reference model (AIRM) and information service reference model (ISRM) including the specific data models: aeronautical information exchange model (AIXM); weather exchange model (WXXM); and flight information exchange model (FIXM).
- **United States:** Europe cooperation is in place on the joint development and maintenance of the AIXM, WXXM, and FIXM data exchange models.

- **AIXM:** the Civil Aviation Bureau of Japan (JCAB) is planning on demonstrating AIM capabilities in 2013.
- **FIXM:** the United States is also validating standards within internal automation systems.
- **FIXM:** Validation of fleet prioritization information exchange is underway with US carriers.
- **WXXM:** the FAA has demonstrated a “publish and subscribe” capability for the exchange of weather information between the FAA and the National Weather Service.

8. REFERENCE DOCUMENTS

8.1 Standards

8.1.1 A new PANS-AIM document planned for availability in 2016 will address all information formats and templates referenced in Annex 15 — *Aeronautical Information Services*.

8.2 Guidance material

- ICAO Doc 8126, *Aeronautical Information Services Manual*

8.3 Approval documents

- Annex 15 — *Aeronautical Information Services*
- Doc 8126 — *Aeronautical Information Services Manual*
- PANS-AIM planned for availability in 2016

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