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MIDANPIRG CNS/ATM/IC Sub-Group (CNS/ATM/IC SG)

Seventh Meeting
(Cairo, Egypt, 07 – 09 October 2013)

Agenda Item 4: Performance Framework for MID Region Air Navigation Planning and Implementation

MID REGION AIR NAVIGATION STRATEGY

(Presented by the Secretariat)

SUMMARY

This paper presents the MID Region Air Navigation Strategy which includes the mechanism for monitoring of the Aviation System Block Upgrades (ASBU) implementation.

Action by the meeting is at paragraph 3.

REFERENCES

- DGCA-MID/2 Report
- MSG/3 Report

1. INTRODUCTION

1.1 The Third Meeting of the MIDANPIRG Steering Group (MSG/3) was held in Cairo, Egypt, from 17 to 19 June 2013. The meeting was attended by a total of Twenty Two (22) participants from Seven (7) MID Region States (Bahrain, Egypt, Iran, Jordan, Lebanon, Saudi Arabia and United Arab Emirates), Two (2) Organisations (IATA and IFALPA) and One (1) Agency (MIDRMA).

2. DISCUSSION

2.1 The MSG/3 meeting recalled that the Global Air Navigation Plan GANP establishes a framework for incremental implementations based on the specific operational profiles and traffic densities of each Region and State, which is accomplished through the evaluation of the Aviation System Block Upgrades (ASBU) modules to identify which of those modules best provide the needed operational improvements. In this respect, it was highlighted that Recommendation 6/1 of the AN-Conf/12 calls upon States and PIRGs to finalize the alignment of Regional Air Navigation Plans with the Fourth Edition of the GANP by May 2014.

2.2 The MSG/3 meeting was apprised of the outcome of the Planning and Implementation Regional Groups (PIRGs) and Regional Aviation Safety Groups (RASGs) Global Coordination Meeting (GCM) that was held in Montreal on 19 March 2013 under the Chairmanship of the President of the ICAO Council. It was highlighted that the outcome of the meeting includes:

a) agreement on establishing regional priorities and targets for air navigation by May 2014 consistent with the GANP/ASBU framework;

b) agreement on the need to measure performance improvements to help demonstrate their positive impact on the environment; and

c) endorsement of the envisioned regional performance dashboard prototype and envisioned determination of an initial set of indicators and metrics for air navigation.

2.3 The meeting recalled that MIDANPIRG/12 through Conclusion 12/47 endorsed 8 Metrics for performance monitoring of the Air Navigation Systems in the MID Region and MIDANPIRG/13 endorsed an initial set of operational improvements for further review/consideration taking into account the outcome of the AN-Conf/12.

2.4 The meeting noted that, in accordance with Recommendation 6/1of the AN-Conf/12 and the outcome of the Planning and Implementation Regional Groups (PIRGs) and Regional Aviation Safety Groups (RASGs) Global Coordination Meeting (GCM) held in Montreal on 19 March2013, the DGCA-MID/2 meeting reiterated the need for the establishment of regional priorities and targets for air navigation by May 2014 consistent with the GANP and ASBU framework. Accordingly, the DGCA-MID/2 meeting:

a) urged States to:

   i. establish a performance measurement strategy for their air navigation system;
   ii. share successful initiatives among each other; and
   iii. support the ICAO MID Regional Office by providing the requisite information to demonstrate operational improvements; and

b) tasked MIDANPIRG and its Steering Group (MSG) with:

   i. the establishment of priorities and targets for air navigation by May 2014, in accordance with Recommendation 6/1 of the Twelfth Air Navigation Conference (AN Conf/12);
   ii. the monitoring and measurement of the agreed air navigation Metrics and indicators, at regional level; and
   iii. the identification of necessary measures/action plans to reach the agreed air navigation targets.

2.5 Based on all of the above and taking into consideration the outcome of the First Meeting of the ANP Ad-hoc Working Group (ANP WG/1) held in Cairo, 27-29 May 2013, the MSG/3 meeting agreed that the following ASBU Block 0 Modules be included in the MID Region Air Navigation Strategy, pending final endorsement by MIDANPIRG/14:

1) B0 – APTA: Optimization of Approach Procedures including vertical guidance
2) B0 – SURF: Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2)
3) B0 – FICE: Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration
4) B0 – DAIM: Service Improvement through Digital Aeronautical Information Management
5) B0 – AMET: Meteorological information supporting enhanced operational efficiency and safety
6) B0 – FRTO: Improved Operations through Enhanced En-Route Trajectories

7) B0 – CDO: Improved Flexibility and Efficiency in Descent Profiles (CDO)
8) B0 – CCO: Improved Flexibility and Efficiency Departure Profiles - Continuous Climb Operations (CCO)

2.6 An extract from the ASBU Document related to the above Eight (8) ASBU Modules is available at **Appendix A** to this working paper, for easy reference.

2.7 Based on all the foregoing, the MSG/3 meeting agreed to the following Draft Conclusion:

DRAFT CONCLUSION 3/1: MID REGION AIR NAVIGATION STRATEGY

That, States and all stakeholders review the draft MID Air Navigation Strategy, and provide comments/inputs to the ICAO MID Regional Office before 15 August 2013 for further review by the CNS/ATM/IC SG/7 meeting before presentation of the final version of the strategy for endorsement by MIDANPIRG/14.

2.8 As a follow-up action to the above Draft Conclusion, the ICAO MID Regional Office issued State Letter Ref.: AN 1/7– 13/169 dated 30 June 2013, requesting States and Users to review the draft MID Air Navigation Strategy, and provide comments/inputs to the ICAO MID Regional Office before 15 August 2013. Few replies were received but with no inputs regarding the Metrics, Key Performance Indicators (KPIs) and Action Plans.

2.9 The ICAO MID Regional Office updated the MID Region Air Navigation Strategy as at **Appendix B** to this working paper, taking into consideration the Global and Regional developments.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) review the revised Draft Version of the MID Air Navigation Strategy at **Appendix B** to this working paper;

b) provide comments/inputs for further improvement of the Startegy; and

c) agree to the following Draft Conclusions:

DRAFT CONCLUSION 7/X: MID REGION AIR NAVIGATION PRIORITIES

That, the MID Region Air Navigation Performance Framework be based on the implementation of the following Block 0 Modules, as a priority: APTA, SURF, FICE, DAIM, AMET, FRTO, CDO and CCO.

DRAFT CONCLUSION 7/X: MID REGION AIR NAVIGATION STRATEGY

That,

a) the MID Region Air Navigation Strategy at ***Appendix XX*** *to the Report on Agenda Item 4 be adopted; and* *b) MID States be urged to:*

  - *i. develop their National Performance Framework, ensuring the alignment with and support to the MID Region Air Navigation Strategy;*
  - *ii. incorporate the agreed MID Region Performance Metrics into their National performance monitoring process; and*
  - *iii. report relevant data necessary for performance monitoring of the Air Navigation Systems to the ICAO MID Regional Office, on annual basis, with a view to monitor the MID Region Key Performance Indicators.*

APPENDIX A

Module N° B*0-APTA*: Optimization of Approach Procedures including vertical guidance

Summary	The use of performance-based navigation (PBN) and ground-based augmentation system (GBAS) landing system (GLS[1]) procedures will enhance the reliability and predictability of approaches to runways, thus increasing safety, accessibility and efficiency. This is possible through the application of Basic global navigation satellite system (GNSS), Baro vertical navigation (VNAV), satellite-based augmentation system (SBAS) and GLS. The flexibility inherent in PBN approach design can be exploited to increase runway capacity.	
Main performance impact as per Doc 9883	KPA-01 – Access and Equity, KPA-02 – Capacity, KPA-04 – Efficiency, KPA-05 – Environment; KPA-10 – Safety.	
Operating environment/ Phases of flight	Approach	
Applicability considerations	This module is applicable to all instrument, and precision instrument runway ends, and to a limited extent, non-instrument runway ends.	
Global concept component(s) as per Doc 9883	AUO – Airspace user operations AO – Aerodrome operations	
Global plan initiatives (GPI)	GPI-5: Area navigation (RNAV) and RNP (PBN) GPI-14: Runway operations GPI-20: WGS84	
Main dependencies	Nil	
Global readiness checklist		Status (ready now or estimated date).
	Standards readiness	✓ (B0 - GLS CAT I only)
	Avionics availability	✓
	Ground system availability	✓
	Procedures available	✓
	Operations approvals	✓

1. Narrative

1.1 General

1.1.1 This module complements other airspace and procedures elements (continuous descent operations (CDO), PBN and airspace management) to increase efficiency, safety, access and predictability.

1.1.2 This module describes what is available regarding approach procedures and can be more widely used now.

1.2 Baseline

1.2.1 Conventional navigation aids (e.g. instrument landing system (ILS), VHF omnidirectional radio range (VOR), non-directional radio beacon (NDB)) have limitations in their ability to support the lowest minima to every runway. In the case of ILS, limitations include cost, the availability of suitable sites for ground infrastructure and an inability to support multiple descent paths to multiple

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[1] *As regards B0, GLS CAT I only. See B1 as regards GLS CAT II/III.*

runway ends. VOR and NDB procedures do not support vertical guidance and have relatively high minima that depend on siting considerations.

1.2.2 In the global context, GNSS-based PBN procedures have been implemented. Some States have implemented large numbers of PBN procedures. There are several GLS (CAT I) procedures in place.

1.3 Change brought by the module

1.3.1 With the exception of ground-based augmentation system (GBAS) for GLS, performance-based navigation (PBN) procedures require no ground-based navaids and allow designers complete flexibility in determining the final approach lateral and vertical paths. PBN approach procedures can be seamlessly integrated with PBN arrival procedures, along with continuous descent operations (CDO), thus reducing aircrew and controller workload and the probability that aircraft will not follow the expected trajectory.

1.3.2 States can implement GNSS-based PBN approach procedures that provide minima for aircraft equipped with basic GNSS avionics with or without Baro VNAV capability, and for aircraft equipped with SBAS avionics. GLS, which is not included in the PBN Manual, requires aerodrome infrastructure but a single station can support approaches to all runways and GLS offers the same design flexibility as PBN procedures. This flexibility provides benefits when conventional aids are out of service due to system failures or for maintenance. Regardless of the avionics fit, each aircraft will follow the same lateral path. Such approaches can be designed for runways with or without conventional approaches, thus providing benefits to PBN-capable aircraft, encouraging equipage and supporting the planning for decommissioning of some conventional aids.

1.3.3 The key to realizing maximum benefits from these procedures is aircraft equipage. Aircraft operators make independent decisions about equipage based on the value of incremental benefits and potential savings in fuel and other costs related to flight disruptions. Experience has shown that operators typically await fleet renewal rather than equip existing aircraft; however retrofits providing RNP/LPV capability are available and have been applied to many bizjet aircraft.

2. Intended Performance Operational Improvement/Metric to determine success

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).

Access and Equity	Increased aerodrome accessibility.
Capacity	In contrast with ILS, the GNSS-based approaches (PBN and GLS) do not require the definition and management of sensitive and critical areas resulting in potentially increased runway capacity.
Efficiency	Cost savings related to the benefits of lower approach minima: fewer diversions, overflights, cancellations and delays. Cost savings related to higher airport capacity in certain circumstances (e.g. closely spaced parallels) by taking advantage of the flexibility to offset approaches and define displaced thresholds.
Environment	Environmental benefits through reduced fuel burn.

Safety	Stabilized approach paths.
Cost Benefit Analysis	Aircraft operators and air navigation service providers (ANSPs) can quantify the benefits of lower minima by using historical aerodrome weather observations and modelling airport accessibility with existing and new minima. Each aircraft operator can then assess benefits against the cost of any required avionics upgrade. Until there are GBAS (CAT II/III) Standards, GLS cannot be considered as a candidate to globally replace ILS. The GLS business case needs to consider the cost of retaining ILS or MLS to allow continued operations during an interference event.

3. Necessary Procedures (Air and Ground)

3.1 The *Performance-based Navigation (PBN) Manual* (Doc 9613), the *Global Navigation Satellite System (GNSS) Manual* (Doc 9849) Annex 10 — *Aeronautical Telecommunications* and the *Procedures for Air Navigation Services — Aircraft Operations*, Volume I — *Flight Procedures* and Volume II — *Construction of Visual and Instrument Flight Procedures* (PANS-OPS, Doc 8168) provide guidance on system performance, procedure design and flight techniques necessary to enable PBN approach procedures. The *World Geodetic System — 1984 (WGS-84) Manual* (Doc 9674) provides guidance on surveying and data handling requirements. The *Manual on Testing of Radio Navigation Aids* (Doc 8071) (Doc 8071), Volume II — *Testing of Satellite-based Radio Navigation Systems* provides guidance on the testing of GNSS. This testing is designed to confirm the ability of GNSS signals to support flight procedures in accordance with the standards in Annex 10. ANSPs must also assess the suitability of a procedure for publication, as detailed in PANS-OPS, Volume II, Part I, Section 2, Chapter 4, Quality Assurance. The *Quality Assurance Manual for Flight Procedure Design* (Doc 9906), Volume 5 –*Validation of Instrument Flight Procedures* provides the required guidance for validation of instrument flight procedures including PBN procedures. Flight validation for PBN procedures is less costly than for conventional aids for two reasons: the aircraft used do not require complex signal measurement and recording systems; and there is no requirement to check signals periodically.

3.2 These documents therefore provide background and implementation guidance for ANSPs, aircraft operators, airport operators and aviation regulators.

4. Necessary System Capability

4.1 Avionics

4.1.1 PBN approach procedures can be flown with basic instrument flight rules (IFR) GNSS avionics that support on board performance monitoring and alerting; these support lateral navigation (LNAV) minima. Basic IFR GNSS receivers may be integrated with Baro VNAV functionality to support vertical guidance to LNAV/vertical navigation (VNAV) minima. In States with defined SBAS service areas, aircraft with SBAS avionics can fly approaches with vertical guidance to LPV minima, which can be as low as ILS CAT I minima when flown to a precision instrument runway, and as low as 250 ft minimum descent altitude (MDA) when flown to an instrument runway. Within an SBAS service area, SBAS avionics can provide advisory vertical guidance when flying conventional non-directional beacon (NDB) and very high frequency omnidirectional radio range (VOR) procedures, thus providing the safety benefits associated with a stabilized approach. Aircraft require avionics to fly GBAS land system (GLS) approaches.

4.2 Ground systems

4.2.1 SBAS-based procedures do not require any infrastructure at the airport served, but SBAS elements (e.g. reference stations, master stations, geostationary (GEO) satellites) must be in place such that this level of service is supported. The ionosphere is very active in equatorial regions, making it very technically challenging for the current generation of SBAS to provide vertically guided approaches in these regions. A GLS station installed at the aerodrome served can support vertically guided CAT I approaches to all runways at that aerodrome.

5. Human Performance

5.1 Human factors considerations

5.1.1 The implementation of approach procedures with vertical guidance enables improved cockpit resource management in times of high and sometime complex workload. By allowing crew procedures to be better distributed during the conduct of the procedure, exposure to operational errors is reduced and human performance is improved. This results in clear safety benefits over procedures that lack guidance along a vertical path. Additionally, some simplification and efficiencies may be achieved in crew training as well.

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 failures, 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 in the operational standards and procedures are required for this module and can be found in the links to the documents in Section 8 to this module. Likewise, the qualification requirements are identified in the regulatory requirements in Section 6 which form an integral part to the implementation of this module.

6. Regulatory/standardization needs and Approval Plan (Air and Ground)

- Regulatory/standardization: use current published criteria as given in Section 8.4 as no new or updated regulatory guidance or standards documentation is needed at this time.

- Approval plans: no new or updated approval criteria are needed at this time. Implementation plans should reflect available aircraft, ground systems and operational approvals.

7. Implementation and Demonstration Activities (As known at the time of writing)

7.1 Current use

- **United States**: The United States has published over 5 000 PBN approach procedures. Of these, almost 2 500 have LNAV/VNAV and LPV minima, the latter based on wide area augmentation system (WAAS) (SBAS). Of the procedures with LPV minima, almost 500 have a 60 m (200 feet) decision height. Current plans call for all (approximately 5 500) runways in the United States to have lateral precision with vertical guidance (LPV) minima by 2016. The United States has a demonstration GLS CAT I procedure at Newark (KEWR); certification is anticipated August 2012 pending resolution of technical and operation issues. The United States currently has a GLS CAT I procedure in operation at Houston (KIAH).

  United States – CAT II/III. Working with industry to develop prototype for CAT II/III operations. Planned operational approval by 2017.

- **Canada**: Canada has published 596 PBN approach procedures with LNAV minima as of July 2011. Of these, twenty-three have LNAV/VNAV minima and fifty-two have LPV minima, the latter based on WAAS (SBAS). Canada plans to add PBN procedures, and to add LNAV/VNAV and LPV minima to those with LNAV-only minima based on demand from aircraft operators. Canada has no GLS installations.

- **Australia**: Australia has published approximately 500 PBN approach procedures with LNAV minima, and has plans to add LNAV/VNAV minima to these procedures; as of June 2011 there were sixty under development. Only about 5 per cent of aircraft operating in Australia have Baro VNAV capability. Australia does not have SBAS, therefore none of the approaches has LPV minima. Australia has completed a GLS CAT I trial at Sydney and will be installing a certified system for testing for full operational approval.

- **France**: France has published fifty PBN procedures with LNAV minima as of June 2011; three have LPV minima; none has LNAV/VNAV minima. The estimates for the end of 2011 are: eighty LNAV, ten LPV and 1 LNAV/VNAV. The objective is to have PBN procedures for 100 per cent of France's IFR runways with LNAV minima by 2016, and 100 per cent with LPV and LNAV/VNAV minima by 2020. France has a single GLS used to support aircraft certification, but not regular operations. France has no plans for CAT I GLS.

- **Brazil**: Brazil has published 146 PBN procedures with LNAV minima as of June 2011; forty-five have LNAV/VNAV minima. There are 179 procedures being developed, 171 of which will have LNAV/VNAV minima. A CAT I GBAS is installed at Rio de Janeiro with plans for GLS to be implemented at main airports from 2014. Brazil does not have SBAS due in part to the challenge of providing single-frequency SBAS service in equatorial regions.

- **India**: PBN based RNAV-1 standard instrument departures (SID) and standard terminal arrivals (STAR) procedures have been implemented in six major airports. India is planning to implement 38 RNP APCH procedures with LNAV and LNAV/VNAV minima at major airport. At some airports, these approach procedures will be linked with RNP-1 STARs.

7.2 Planned or ongoing trials

- **India**: India's SBAS system called GAGAN (GPS Aided Geo Augmented Navigation) is being developed. The certified GAGAN system will be available by June 2013 and should support the APAC region and beyond. India has planned to implement GLS to support satellite-based navigation in terminal control area (TMA), to increase accessibility to airports. The first pilot project will be undertaken in 2012 at Chennai.

8. Reference Documents

8.1 Standards

ICAO Annex 10 — *Aeronautical Telecommunications*, Volume I — *Radio Navigation Aids*. As of 2011 a draft Standards and Recommended Practices (SARPs) amendment for GLS to support CAT II/III approaches is completed and is being validated by States and industry.

8.2 Procedures

ICAO Doc 8168, *Procedures for Air Navigation Services — Aircraft Operations*

8.3 Guidance material

- ICAO Doc 9674, *World Geodetic System — 1984 (WGS-84) Manual*
- ICAO Doc 9613*, Performance-based Navigation (PBN) Manual*
- ICAO Doc 9849, *Global Navigation Satellite System (GNSS) Manual*
- ICAO Doc 9906, *Quality Assurance Manual for Flight Procedure Design*, Volume 5 — *Validation of Instrument Flight Procedures*
- ICAO Doc 8071, *Manual on Testing of Radio Navigation Aids,* Volume II — *Testing of Satellite-based Radio Navigation Systems*
- ICAO Doc 9931, *Continuous Descent Operations (CDO) Manual*

8.4 Approval documents

- FAA AC 20-138, TSO-C129/145/146
- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*
- ICAO *Flight Plan Classification*
- ICAO Doc 8168, *Aircraft Operations*
- ICAO Doc 9613, *Performance Based Navigation (PBN) Manual*
- ICAO Annex 10 — *Aeronautical Telecommunications*
- ICAO Annex 11 — *Air Traffic Services*
- ICAO Doc 9674, *World Geodetic System — 1984 (WGS-84) Manual*

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Module N° B*0-SURF:* Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2)

Summary	Basic A-SMGCS provides surveillance and alerting of movements of both aircraft and vehicles on the aerodrome thus improving runway/aerodrome safety. ADS-B information is used when available (ADS-B APT).	
Main performance impact as per Doc 9883	KPA- 01 – Access and Equity, KPA-02 – Capacity, KPA-04 – Efficiency, KPA-05 – Environment, KPA-10 – Safety.	
Operating environment/ Phases of flight	Aerodrome surface movements (aircraft + vehicles), taxi, push-back, parking	
Applicability considerations	A-SMGCS is applicable to any aerodrome and all classes of aircraft/vehicles. Implementation is to be based on requirements stemming from individual aerodrome operational and cost-benefit assessments. ADS B APT, when applied is an element of A-SMGCS, is designed to be applied at aerodromes with medium traffic complexity, having up to two active runways at a time and the runway width of minimum 45 m.	
Global concept component(s) as per Doc 9854	AO – Aerodrome operations CM – Conflict management	
Global plan initiatives (GPI)	GPI-9: Situational awareness GPI-13: Aerodrome design and management GPI-16: Decision support systems and alerting systems GPI-18: Electronic information services in the global plan initiatives	
Main dependencies	Linkage with B*0-ACDM* and B*0-RSEQ*	
Global readiness checklist		Status (indicate ready with a tick or input date)
	Standards readiness	√
	Avionics availability	√
	Infrastructure availability	√
	Ground automation availability	√
	Procedures available	√
	Operations approvals	√

1. Narrative

1.1 General

1.1.1 This module builds upon traditional surface movement guidance and control system (SMGCS) implementation (visual surveillance, aerodrome signage, lighting and markings) by the introduction of capabilities enhancing air traffic control (ATC) situational awareness through:

a) display to the aerodrome controller of the position of all aircraft on the aerodrome movement area;

b) display to the aerodrome controller of all vehicles on the aerodrome manoeuvring area; and

c) generation of runway incursion alerts (where local operational, safety and cost-benefit analyses so warrant).

1.1.2 For advanced surface movement guidance and control systems (A-SMGCS), the facilities and procedures also represent a significant improvement over and above performance levels associated to conventional SMGCS. The entire A-SMGCS concept, being based on a set of forward and backward compatible groupings of modular functionalities, will ensure these B0 facilities and procedures fully support seamless transitions to the more sophisticated facilities and procedures of A-SMGCS described in Blocks 1 and 2. The B0 level of implementation, corresponding to levels 1 and 2 of the A-SMGCS concept and being associated to the provision of ATS, is independent of aircraft equipage beyond that associated with cooperative surveillance equipage (e.g. SSR Mode S or A/C transponders).

1.1.3 For automatic dependent surveillance—broadcast (ADS-B) APT the facilities and procedures will be the same with the performance levels associated to conventional SMGCS. The B0 level of implementation is dependent of aircraft/vehicle ADS-B Out equipage.

1.2 **Baseline**

1.2.1 Surface operations historically have been managed by use of visual scanning by both ANSP personnel and flight crew, both as the basis for taxi management as well as aircraft navigation and separation. These operations are significantly impeded during periods of reduced visibility (weather obscuration, night) and high demand, e.g. when a large proportion of aircraft are from the same operator and/or of the same aircraft type. In addition, remote areas of the aerodrome surface are difficult to manage if out of direct visual surveillance. As a result, efficiency can be significantly degraded, and safety services are unevenly provided. Complementary to such historical means of aerodrome traffic management, enhanced surface situational awareness has been based upon use of an aerodrome surface movement primary radar system and display (SMR). This permits the surveillance of all aircraft and ground vehicles without any need for cooperative surveillance equipment installed on the aircraft/vehicles. This improvement allows ANSP personnel to better maintain awareness of ground operations during periods of low visibility. In addition, the presence of safety logic allows for limited detection of runway incursions.

1.3 **Change brought by the module**

1.3.1 This module implements:

- Additional capabilities to the aerodrome surveillance environment by taking advantage of cooperative surveillance that provides the means to establish the position of all aircraft and vehicles and to specifically identify targets with individual flight/vehicle identification. Ground vehicles operating on the manoeuvring area will be equipped with cooperative surveillance transponders compatible with the specific A-SMGCS equipment installed so as to be visible to tower ground surveillance display systems.

- SMR-like capabilities by implementing ADS-B APT at those aerodromes where surveillance is not available.

1.4 **Element 1 – Surveillance**

1.4.1 In the case of A-SMGCS, this element enhances the primary radar surface surveillance with the addition of at least one cooperative surface surveillance system. These systems include multilateration, secondary surveillance radar Mode S, and ADS-B. As with TMA and en-route secondary surveillance radars/ADS-B, the cooperative aspect of the surveillance allows for matching of equipped surveillance targets with flight data, and also reduces clutter and degraded operation associated with primary surveillance. The addition of cooperative surveillance of aircraft and vehicles adds a significant positive benefit to the performance of safety logic, as the tracking and short-term trajectory projection capabilities are improved with the higher quality surveillance. The addition of this capability also provides for a marginal improvement in routine management of taxi operations and more efficient sequencing of aircraft departures.

1.4.2 In the case of ADS-B APT, as an element of an A-SMGCS system, it provides controllers with traffic situational awareness on movement areas. The provision of surveillance information to the controller will allow the deployment of SMGCS procedures, augmenting the controller's situational awareness and helping the controller to manage the traffic in a more efficient way. In this respect, the ADS-B APT application does not aim to reduce the occurrence of runway incursions, but may reduce the occurrence of runway collisions by assisting in the detection of the incursions.

1.5 **Element 2 – Alerting**

1.5.1 In the case of A-SMGCS, where installed and operated, alerting with flight identification information also improves the ATC response to situations that require resolution such as runway incursion incidents and improved response times to unsafe surface situations. Levels of sophistication as regards this functionality currently vary considerably between the various industrial solutions being offered. B0 implementations will serve as important initial validation for improved algorithms downstream.

1.5.2 In the case of ADS-B APT, system generated alerting processes and procedures have not been defined (as this is considered premature at this development stage). It is possible that future variations of the ADS-B APT application will assess the surveillance requirements necessary to support alerting functions.

2. Intended Performance Operational Improvement/Metric to determine success

Access and Equity	A-SMGCS: improves access to portions of the manoeuvring area obscured from view of the control tower for vehicles and aircraft. Sustains an improved aerodrome capacity during periods of reduced visibility. Ensures equity in ATC handling of surface traffic regardless of the traffic's position on the aerodrome. ADS-B APT: , as an element of an A-SMGCS system, provides traffic situational awareness to the controller in the form of surveillance information. The availability of the data is dependent on the aircraft and vehicle level of equipage.
Capacity	A-SMGCS: sustained levels of aerodrome capacity for visual conditions reduced to minima lower than would otherwise be the case. ADS-B APT: as an element of an A-SMGCS system, potentially improves capacity

	for medium complexity aerodromes.
Efficiency	A-SMGCS: reduced taxi times through diminished requirements for intermediate holdings based on reliance on visual surveillance only. ADS-B APT: as an element of an A-SMGCS system, potentially reduces taxi times by providing improved traffic situational awareness to controllers.
Environment	Reduced aircraft emissions stemming from improved efficiencies.
Safety	A-SMGCS: reduced runway incursions. Improved response to unsafe situations. Improved situational awareness leading to reduced ATC workload. ADS-B APT: as an element of an A-SMGCS system, potentially reduces the occurrence of runway collisions by assisting in the detection of the incursions.
Cost Benefit Analysis	A-SMGCS: a positive CBA can be made from improved levels of safety and improved efficiencies in surface operations leading to significant savings in aircraft fuel usage. As well, aerodrome operator vehicles will benefit from improved access to all areas of the aerodrome, improving the efficiency of aerodrome operations, maintenance and servicing. ADS-B APT: as an element of an A-SMGCS system less costly surveillance solution for medium complexity aerodromes.
Human Performance	Reduced ATC workload. Improved ATC efficiencies.

3. Necessary Procedures (Air and Ground)

3.1 Procedures required in support of B0 operations are those associated with the provision of the aerodrome control service. Flight crew procedures specific to A-SMGCS are not necessary beyond those associated with basic operation of aircraft transponder systems and settings of aircraft identification. Vehicle drivers will need to be in a position to effectively operate vehicle transponder systems.

3.2 ATC will be required to apply procedures specific to A-SMGCS for the purpose of establishing aircraft/vehicle identification. In addition, ATC will be required to apply procedures associated specifically to the use of A-SMGCS as a replacement to visual observation.

4. Necessary System Capability

4.1 Avionics

4.1.1 Existing aircraft ADS-B and/or SSR transponder systems, including correct setting of aircraft identification.

4.2 Vehicles

4.2.1 Vehicle cooperative transponder systems, type as a function of the local A-SMGCS installation. Industry solutions readily available.

4.3 Ground systems

4.3.1 A-SMGCS: the surface movement radar should be complemented by a cooperative surveillance means allowing tracking aircraft and ground vehicles. A surveillance display including some alerting functionalities is required in the tower.

4.3.2 ADS-B APT: cooperative surveillance infrastructure deployed on the aerodrome surface; installation of a tower traffic situational awareness display.

5. Human Performance

5.1 Human factors considerations

5.1.1 Workload analyses will be necessary to ensure ATC can cope with increased aerodrome capacities in reduced visual conditions using A-SMGCS. ATC response to A-SMGCS generated runway incursion alarms and warnings will require human factors assessments to ensure that ATC performance in this regard does in fact improve and not diminish. Human factors assessments will also be necessary for the assessment of the compatibility of A-SMGCS tower display installations with other tower surveillance display systems.

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 (see Section 6 for examples). The possibility of latent failures 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 in the operational standards and procedures are required for this module and can be found in the links to the documents in Section 8 to this module. Likewise, the qualifications requirements are identified in the regulatory requirements in Section 6 which form an integral part to the implementation of this module.

6. Regulatory/standardization needs and Approval Plan (Air and Ground)

6.1 Standards approved for aerodrome multilateration, ADS-B and safety logic systems exist for use in Europe, the United States and other Member States. Standards for surface movement radar (SMR) exist for use globally.

7. Implementation and Demonstration Activities (As known at time of writing)

7.1 Current use

7.1.1 A-SMGCS responding to B0 functionality is already broadly deployed at a multitude of aerodromes globally. Several of those installations also include runway incursion alerting functionality, of varying degrees of sophistication and reliability.

7.2 Planned or on-going trials

7.2.1 The United States is supporting deployment to additional aerodromes, using various combinations of primary and secondary surveillance. This includes low cost ground surveillance programmes which may unite a more affordable primary radar system with ADS-B. Initial operational capabilities are expected in the 2012-2016 timeframe.

8. Reference Documents

8.1 Standards

- Community Specification on A-SMGCS Levels 1 and 2
- ICAO Doc 9924, *Aeronautical Surveillance Manual*
- ICAO Doc 9871, *Technical Provisions for Mode S Services and Extended Squitter*
- ICAO Doc 9830, *Advanced Surface Movement Guidance and Control Systems (A-SMGCS) Manual*
- ICAO Doc 7030/5, (EUR/NAT) *Regional Supplementary Procedures*, Section 6.5.6 and 6.5.7
- FAA Advisory Circulars
- AC120-86 Aircraft Surveillance Systems and Applications
- AC120-28D Criteria for approval of Category III Weather Minima for Take-off, Landing, and Rollout
- AC120-57A Surface Movement Guidance and Control System
- Avionics standards developed by RTCA SC-186/Eurocae WG-51 for ADS-B
- Aerodrome map standards developed by RTCA SC-217/Eurocae WG-44
- EUROCAE ED 163 Safety, Performance and Interoperability Requirements document for ADS-B Airport Surface surveillance application (ADS-B APT)

8.2 ATC procedures

- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*
- ICAO Doc 7030, *Regional Supplementary Procedures* (EUR SUPPS)

8.3 Guidance material

- FAA NextGen Implementation Plan
- European ATM Master Plan

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Module N° B0-*FICE*: Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration

Summary	To improve coordination between air traffic service units (ATSUs) by using ATS interfacility data communication (AIDC) defined by the ICAO *Manual of Air Traffic Services Data Link Applications* (Doc 9694). The transfer of communication in a data link environment improves the efficiency of this process particularly for oceanic ATSUs.	
Main performance impact as per Doc 9883	KPA-02 – Capacity, KPA-04 – Efficiency**,** KPA-07 – Global Interoperability, KPA-10 – Safety.	
Operating environment/ Phases of flight	All flight phases and all type of ATS units.	
Applicability considerations	Applicable to at least two area control centres (ACCs) dealing with en-route and/or terminal control area (TMA) airspace. A greater number of consecutive participating ACCs will increase the benefits.	
Global concept component(s) as per Doc 9854	CM – conflict management	
Global plan initiatives (GPI)	GPI-16: Decision support systems	
Main dependencies	Linkage with B*0-TBO*	
Global readiness checklist		Status (ready now or estimated date)
	Standards readiness	√
	Avionics availability	No requirement
	Ground systems availability	√
	Procedures available	√
	Operations approvals	√

1. Narrative

1.1 General

1.1.1 Flights which are being provided with air traffic services are transferred from one air traffic services (ATS) unit to the next in a manner designed to ensure safety. In order to accomplish this objective, it is a standard procedure that the passage of each flight across the boundary of the areas of responsibility of the two units is co-ordinated between them beforehand and that the control of the flight is transferred when it is at, or adjacent to, the said boundary.

1.1.2 Where it is carried out by telephone, the passing of data on individual flights as part of the coordination process is a major support task at ATS units, particularly at area control centres (ACCs). The operational use of connections between flight data processing systems (FDPSs) at ACCs replacing phone coordination (on-line data interchange (OLDI)) is already proven in Europe.

1.1.3 This is now fully integrated into the ATS interfacility data communications (AIDC) messages in the *Procedures for Air Navigation Services — Air Traffic Management,* (PANS-ATM, Doc 4444) which describes the types of messages and their contents to be used for operational communications between ATS unit computer systems. This type of data transfer (AIDC) will be the basis for migration of data communications to the aeronautical telecommunication network (ATN).

1.1.4 The AIDC module is aimed at improving the flow of traffic by allowing neighbouring air traffic services units to exchange flight data automatically in the form of coordination and transfer messages.

1.1.5 With the greater accuracy of messages based on the updated trajectory information contained in the system and where possible updated by surveillance data, controllers have more reliable information on the conditions at which aircraft will enter in their airspace of jurisdiction with a reduction of the workload associated to flight coordination and transfer. The increased accuracy and data integrity permits the safe application of reduced separations.

1.1.6 Combined with air-ground data link applications, AIDC also allows the transfer of aircraft logon information and the timely initiation of establishing controller-pilot data link communications (CPDLC) by the next air traffic control (ATC) unit with the aircraft.

1.1.7 These improvements outlined above translate directly into a combination of performance improvements.

1.1.8 Information exchanges between flight data processing systems are established between air traffic services units for the purpose of notification, coordination and transfer of flights and for the purpose of civil/military coordination. These information exchanges rely upon appropriate and harmonized communication protocols to secure their interoperability.

1.1.9 Information exchanges apply to:

a) communication systems supporting the coordination procedures between air traffic services units using a peer-to-peer communication mechanism and providing services to general air traffic; and

b) communication systems supporting the coordination procedures between air traffic services units and controlling military units, using a peer-to-peer communication mechanism.

1.2 **Baseline**

1.2.1 The baseline for this module is the traditional coordination by phone, and procedural and/or radar distance/time separations.

1.3 **Change brought by the module**

1.3.1 The module makes available a set of messages to describe consistent transfer conditions via electronic means across ATS units' boundaries. It consists of the implementation of the set of AIDC messages in the flight data processing systems (FDPS) of the different ATS units involved and the establishment of a Letter of Agreement (LoA) between these units to set the appropriate parameters.

1.3.2 Prerequisites for the module, generally available before its implementation, are an ATC system with flight data processing functionality and a surveillance data processing system connected to each other.

1.4 Other remarks

1.4.1 This module is a first step towards the more sophisticated 4D trajectory exchanges between both ground/ground and air/ground according to the ICAO *Global Air Traffic Management Operational Concept* (Doc 9854).

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).

Capacity	Reduced controller workload and increased data integrity supporting reduced separations translating directly to cross sector or boundary capacity flow increases.
Efficiency	The reduced separation can also be used to more frequently offer aircraft flight levels closer to the flight optimum; in certain cases, this also translates into reduced en-route holding.
Global interoperability	Seamlessness: the use of standardized interfaces reduces the cost of development, allows air traffic controllers to apply the same procedures at the boundaries of all participating centres and border crossing becomes more transparent to flights.
Safety	Better knowledge of more accurate flight plan information.
Cost Benefit Analysis	Increase of throughput at ATS unit boundary and reduced ATCO workload will outweigh the cost of FDPS software changes. The business case is dependent on the environment.

3. NECESSARY PROCEDURES (AIR AND GROUND)

3.1 Required procedures exist. They need local analysis of the specific flows and should be spelled out in a Letter of Agreement between ATS units; the experience from other regions can be a useful reference.

4. Necessary System capability

4.1 Avionics

4.1.1 No specific airborne requirements.

4.2 Ground systems

4.2.1 Technology is available. It consists in implementing the relevant set of AIDC messages in flight data processing and could use the ground network standard AFTN-AMHS or ATN. Europe is presently implementing it in ADEXP format over IP wide area networks.

4.2.2 The technology also includes for oceanic ATSUs a function supporting transfer of communication via data link.

5. Human Performance

5.1 Human factors considerations

5.1.1 Ground interoperability reduces voice exchange between ATCOs and decreases workload. A system supporting appropriate human-machine interface (HMI) for ATCOs is required.

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 HMI has been considered from both a functional and ergonomic perspective (see Section 6 for examples). The possibility of latent failures, however, continues to exist and vigilance is required during all implementation activity. In addition it is important 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 To make the most of the automation support, training in the operational standards and procedures will be required and can be found in the links to the documents in Section 8 to this module. Likewise, the qualifications requirements are identified in the regulatory requirements in Section 6 which are integral to the implementation of this module**.**

6. Regulatory/standardization needs and Approval Plan (Air AND Ground)

- Regulatory/standardization: use current published criteria that include:

  a) ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*;
  b) EU Regulation, EC No 552/2004.

- Approval plans: to be determined based on regional consideration of ATS interfacility data communications (AIDC).

7. Implementation and demonstration activities (As known at time of writing)

7.1 Although already implemented in several areas, there is a need to complete the existing SARPs to improve harmonization and interoperabiltiy. For Oceanic data link application, North Atlantic (NAT) and Asia and Pacific (APAC) (cf ISPACG PT/8- WP.02 - GOLD) have defined some common coordination procedures and messages between oceanic centres for data link application (ADS-C CPDLC).

7.2 Current use

- **Europe:** It is mandatory for exchange between ATS units. http://europa.eu/legislation_summaries/transport/air_transport/l24070_en.htm

  The European Commission has issued a mandate on the interoperability of the European air traffic management network, concerning the coordination and transfer (COTR) between ATS units through REG EC 1032/2006 and the exchange of flight data between ATS units in support of air-ground data link through REG EC 30/2009. This is based on the standard OLDI-Ed 4.2 and ADEXP-Ed 3.1.

- **EUROCONTROL:** Specification of interoperability and performance requirements for the flight message transfer protocol (FMTP). The available set of messages to describe and negotiate consistent transfer conditions via electronic means across centres' boundaries have been used for trials in Europe in 2010 within the scope of EUROCONTROL's FASTI initiative.

- **India:** AIDC implementation is in progress in Indian airspace for improved coordination between ATC centres. Major Indian airports and ATC centres have integrated ATS automation systems having AIDC capability. AIDC functionality is operational between Mumbai and Chennai ACCs. AIDC will be implemented within India by 2012. AIDC trials are underway between Mumbai and Karachi (Pakistan) and are planned between India and Muscat in coordination with Oman.

- **AIDC:** is in use in the Asia-Pacific Region, Australia, New-Zealand, Indonesia and others.

7.3 Planned or ongoing activities

7.3.1 To be determined.

7.4 Currently in operation

7.4.1 To be determined.

8. Reference Documents

8.1 Standards

- ICAO Doc 4444, *Procedures for Air Navigation Services - Air Traffic Management,* Appendix 6 - *ATS Interfacility Data Communications (AIDC) Messages*

- ICAO Doc 9880, *Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI Standards and Protocols*, Part II — *Ground-Ground Applications — Air Traffic Services Message Handling Services (ATSMHS).*

8.2 Procedures

8.2.1 To be determined.

8.3 Guidance material

- ICAO Doc 9694, *Manual of Air Traffic Services Data Link Applications;* Part 6;

- GOLD Global Operational Data Link Document (APANPIRG, NAT SPG), June 2010;

- Pan Regional Interface Control Document for Oceanic ATS Interfacility Data Communications (PAN ICD) Coordination Draft Version 0.3. 31 August 2010;

- Asia/Pacific Regional Interface Control Document (ICD) for ATS Interfacility Data Communications (AIDC) available at http://www.bangkok.icao.int/edocs/icd_aidc_ver3.pdf, ICAO Asia/Pacific Regional Office.

- EUROCONTROL Standard for On-Line Data Interchange (OLDI); and EUROCONTROL Standard for ATS Data Exchange Presentation (ADEXP).

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Module N° B*0-DATM*: 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 9883	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 9829, 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 (AICM)/aeronautical information exchange model (AIXM), 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).

Cost Effectiveness	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.
Environment	Reducing the time necessary to promulgate information concerning airspace status will allow for more effective airspace utilization and allow improvements in trajectory management.
Global Interoperability	Essential contribution to interoperability.
Safety	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.
Cost Benefit Analysis	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 Luxemburg, 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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Module N° B*0-AMET*: Meteorological information supporting enhanced operational efficiency and safety

<table>
<tr><td>Summary</td><td colspan="2">Global, regional and local meteorological information:
a) forecasts provided by world area forecast centres (WAFC), volcanic ash advisory centres (VAAC) and tropical cyclone advisory centres (TCAC);
b) aerodrome warnings to give concise information of meteorological conditions that could adversely affect all aircraft at an aerodrome including wind shear; and
c) SIGMETs to provide information on occurrence or expected occurrence of specific en-route weather phenomena which may affect the safety of aircraft operations and other operational meteorological (OPMET) information, including METAR/SPECI and TAF, to provide routine and special observations and forecasts of meteorological conditions occurring or expected to occur at the aerodrome.
This information supports flexible airspace management, improved situational awareness and collaborative decision making, and dynamically-optimized flight trajectory planning.
This module includes elements which should be viewed as a subset of all available meteorological information that can be used to support enhanced operational efficiency and safety.</td></tr>
<tr><td>Main performance impact as per Doc 9883</td><td colspan="2">KPA-02 – Capacity, KPA-03 – Cost-effectiveness, KPA-04 – Efficiency, KPA-05 – Environment, KPA-06 – Flexibility, KPA-07 – Global interoperability, KPA-08 – Participation by the ATM community, KPA-09 – Predictability, KPA-10 – Safety.</td></tr>
<tr><td>Operating environment/ Phases of flight</td><td colspan="2">All phases of flight.</td></tr>
<tr><td>Applicability considerations</td><td colspan="2">Applicable to traffic flow planning, and to all aircraft operations in all domains and flight phases, regardless of level of aircraft equipage.</td></tr>
<tr><td>Global concept component(s) as per Doc 9854</td><td colspan="2">AOM – airspace operations and management
DCB – demand and capacity balancing
AO – aerodrome operations</td></tr>
<tr><td>Global plan initiatives (GPI)</td><td colspan="2">GPI-19: Meteorological systems
GPI-6: Air traffic flow management
GPI-16: Decision support systems and alerting systems</td></tr>
<tr><td>Main dependencies</td><td colspan="2">None. Meteorological information and supporting distribution systems are in existence today.</td></tr>
<tr><td rowspan="6">Global readiness checklist</td><td></td><td>Status (ready now or estimated date).</td></tr>
<tr><td>Standards readiness</td><td>√</td></tr>
<tr><td>Avionics availability</td><td>√</td></tr>
<tr><td>Ground system availability</td><td>√</td></tr>
<tr><td>Procedures available</td><td>√</td></tr>
<tr><td>Operations approvals</td><td>√</td></tr>
</table>

1. Narrative

1.1 General

1.1.1 Elements 1 to 3 of this module illustrate the meteorological information made available by world area forecast centres (WAFC), volcanic ash advisory centres (VAAC) and tropical cyclone advisory centres (TCAC) that can be used by the air traffic management (ATM) community to support dynamic and flexible management of airspace, improved situational awareness and collaborative decision making, and (in the case of WAFS forecasts) dynamically-optimized flight trajectory planning.

1.1.2 Elements 4 and 5 of this module illustrate the meteorological information issued by aerodrome meteorological offices in the form of aerodrome warnings, wind shear warnings and alerts (including those generated by automated meteorological systems) that contribute to improving safety and maximizing runway capacity. In some instances, the systems used for the detection of wind shear (such as ground based LIDAR) have proven utility in wake turbulence detection and tracking/monitoring, and thus also support the improving safety and maximizing runway capacity from a wake turbulence encounter prevention perspective.

1.1.3 Element 6 of this module describes SIGMET which is meteorological information provided by meteorological watch offices (MWO) on the occurrence and/or expected occurrence of specified en-route weather phenomena (including severe turbulence, severe icing and thunderstorms) which may affect the safety of aircraft operations. In addition, element 6 of this module describes other operational meteorological (OPMET) information (including METAR/SPECI and TAF) which is provided by aerodrome meteorological offices on observed or forecast meteorological conditions at the aerodrome.

1.1.4 It should be recognized that elements 1 to 6 herein represent a subset of all available meteorological information that can be used to support enhanced operational efficiency and safety. Other such meteorological information that is not described here includes, for example, local routine and local special reports at the aerodrome, aircraft observations and reports, and aeronautical climatological information.

1.2 Baseline

1.2.1 WAFCs within the framework of the world area forecast system (WAFS) prepare global gridded forecasts of upper wind, upper-air temperature and humidity, geopotential altitude of flight levels, flight level and temperature of tropopause, direction, speed and flight level of maximum wind, cumulonimbus clouds, icing, and clear-air and in-cloud turbulence. These global gridded forecasts are issued 4-times per day, with fixed time validity T+0 to T+36 at 3-hour time-steps. In addition, the WAFCs prepare global forecasts of significant weather (SIGWX) phenomena in binary code form. These global forecasts of SIGWX phenomena are issued 4-times per day, with validity at T+24. The United Kingdom and United States are designated as WAFC provider States. Accordingly, WAFCs London and Washington make available the aforementioned forecasts on the ICAO Aeronautical Fixed Service (AFS).

1.2.2 VAACs within the framework of the International Airways Volcano Watch (IAVW) respond to a notification that a volcano has erupted, or is expected to erupt or volcanic ash is reported in its area of responsibility. The VAACs monitor relevant satellite data to detect the existence and extent of volcanic ash in the atmosphere in the area concerned, and activate their volcanic ash numerical trajectory/dispersion model in order to forecast the movement of any ash cloud that has been detected or reported. In support, the VAACs also use surface-based observations and pilot reports to assist in the detection of volcanic ash. The VAACs issue advisory information (in plain language textual form and graphical form) concerning the extent and forecast movement of the volcanic ash cloud, with fixed time validity T+0 to T+18 at 6-hour time-steps. The VAACs issue these forecasts at least every six hours until such time as the volcanic ash cloud is no longer identifiable from satellite data, no further reports of volcanic ash are received from the area, and no further eruptions of the volcano are reported. The VAACs maintain a 24-hour watch. Argentina, Australia, Canada, France, Japan, New Zealand, the United Kingdom and the United States are designated (by regional air navigation agreement) as the VAAC provider States. Accordingly, VAACs Buenos Aires, Darwin, Montreal, Toulouse, Tokyo, Wellington, London, Anchorage and Washington make available the aforementioned advisories on the ICAO AFS.

1.2.3 TCACs monitor the development of tropical cyclones in their area of responsibility, using relevant satellite data, meteorological radar data and other meteorological information. The TCACs are meteorological centres designated by regional air navigation agreement on the advice of the World Meteorological Organization (WMO). The TCACs issue advisory information (in plain language textual form and graphical form) concerning the position of the tropical cyclone centre, its direction and speed of movement, central pressure and maximum surface wind near the centre, with fixed time validity T+0 to T+24 at 6-hour time-steps. The TCACs issue updated advisory information for each tropical cyclone, as necessary, but at least every six hours. Australia, Fiji, France, India, Japan and the United States are designated (by regional air navigation agreement) as TCAC provider States. Aforementioned advisories are made available on the ICAO AFS, through TCACs located in Darwin, Nadi, La Reunion, New Delhi, Tokyo, Honolulu and Miami.

1.2.4 Aerodrome warnings provide concise information of observed or expected meteorological conditions that could adversely affect aircraft on the ground, including parked aircraft, and the aerodrome facilities and services.

1.2.5 Wind shear warnings are prepared for aerodromes where wind shear is considered a factor. Wind shear warnings give concise information on the observed or expected existence of wind shear which could adversely affect aircraft on the approach path or take-off path or during circling approach between runway level and 500 m (1 600 ft) above that level and aircraft on the runway during the landing roll or take-off run. Note that where local topography has been shown to produce significant wind shears at heights in excess of 500 m (1 600 ft) above runway level, then 500 m (1,600 ft) is not to be considered restrictive.

1.2.6 SIGMETs are information that describes the location of specified en-route weather phenomena which may affect the safety of aircraft operations. SIGMETs are issued by MWOs for such phenomena as thunderstorms, turbulence, icing, mountain wave, radioactive clouds, volcanic ash clouds and tropical cyclone. The latter two categories of SIGMETs may be based on information provided in the appropriate advisories from the respective VAACs and TCACs.

1.2.7 In addition to SIGMET information, other forms of OPMET information, including METAR/SPECI and TAF, provide information on the observed occurrence of specified meteorological conditions at the aerodrome (surface wind, visibility, weather, cloud, temperature and atmospheric pressure) and the expected occurrence of these meteorological conditions at the aerodrome for a specified period. Such OPMET information, and amendments or corrections thereto, is issued by aerodrome meteorological offices for the aerodromes concerned.

1.3 Change brought by the module

1.3.1 The global availability of meteorological information as provided with the framework of the WAFS and IAVW enhances the pre-tactical and/or tactical decision making for aircraft surveillance, air traffic flow management and flexible/dynamic aircraft routing. Similar information is also provided by TCACs and MWOs in support of ATM decisions. The locally-arranged availability of aerodrome warnings, wind shear warnings and alerts (where wind shear is considered a factor), contributes to improved safety and maximized runway capacity during adverse meteorological conditions. Wind shear detection systems can, in some instances, be utilized for wake turbulence detection and tracking/monitoring. The availability of routine and special observations and forecasts of meteorological conditions occurring or expected to occur at the aerodrome enhances pre-tactical and/or tactical decision making.

1.3.2

1.4 Element 1: WAFS

1.4.1 The WAFS is a worldwide system within which two designated WAFCs provide aeronautical meteorological en-route forecasts in uniform standardized formats. The grid point forecasts are prepared by the WAFCs in a regular grid with a horizontal resolution of 1.25 degrees of latitude and longitude, and issued in binary code form using the GRIB code form as prescribed by WMO. The significant weather (SIGWX) forecasts are issued by the WAFCs in accordance with the provisions in Annex 3 — *Meteorological Service for International Air Navigation* (Chapter 3 and Appendix 2) in binary code form using the BUFR code form prescribed by WMO and in PNG-chart form as formalized backup means. ICAO administers the WAFS with the cooperation of the WAFC provider States and concerned international organizations through the World Area Forecast System Operations Group (WAFSOPSG).

1.5 Element 2: IAVW

1.5.1 The IAVW ensures international arrangements for monitoring and providing advisories to MWOs and aircraft operators of volcanic ash in the atmosphere. The advisories support the issuance of SIGMET on these events by the respective MWOs. The IAVW is based on the cooperation of aviation and non-aviation operational units using information derived from observing sources and networks that are provided by States for the detection of volcanic ash in the atmosphere. The forecasts issued by the nine designated VAACs are in plain language text and PNG chart form. The advisory information on volcanic ash is prepared by VAACs in accordance with Annex 3 (Chapter 3 and Appendix 2). ICAO administers the IAVW with the cooperation of the VAAC provider States and concerned international organizations through the International Airways Volcano Watch Operations Group (IAVWOPSG). Additionally, ICAO recognizes the importance of State volcano observatories as part of the world organization of volcano observatories in their role o providing information o the pre-eruption and eruption of volcanoes.

1.6 Element 3: Tropical cyclone watch

1.6.1 TCAC, per regional air navigation agreement, monitor the formation, movement and degradation of tropical cyclones. The forecasts issued by the TCACs are in plain language text and graphical form. The advisory information on tropical cyclones is prepared by TCACs in accordance with Annex 3 (Chapter 3 and Appendix 2). The advisories support the issuance of SIGMET on these events by the respective MWOs.

1.7 Element 4: Aerodrome warnings

1.7.1 Aerodrome warnings give concise information of meteorological conditions that could adversely affect aircraft on the ground, including parked aircraft, and the aerodrome facilities and services. Aerodrome warnings are issued in accordance with Annex 3 (Chapter 7 and Appendix 6) where required by operators or aerodrome services. Aerodrome warnings should relate to the occurrence or expected occurrence of one or more of the following phenomena: tropical cyclone, thunderstorm, hail, snow, freezing precipitation, hoar frost or rime, sandstorm, dust-storm, rising sand or dust, strong surface wind and gusts, squall, frost, volcanic ash, tsunami, volcanic ash deposition, toxic chemicals, and other phenomena as agreed locally. Aerodrome warnings are issued usually for validity periods of not more than 24 hours. Aerodrome warnings are disseminated within the aerodrome in accordance with local arrangements to those concerned, and should be cancelled when the conditions are no longer occurring and/or no longer expected to occur at the aerodrome.

1.8 Element 5: Wind shear warnings and alerts

1.8.1 Wind shear warnings are prepared for aerodromes where wind shear is considered a factor, issued in accordance with Annex 3 (Chapter 7 and Appendix 6) and disseminated within the aerodrome in accordance with local arrangements to those concerned. Wind shear conditions are normally associated with the following phenomena: thunderstorms, microbursts, funnel cloud (tornado or waterspout), and gust fronts, frontal surfaces, strong surface winds coupled with local topography; sea breeze fronts, mountain waves (including low-level rotors in the terminal area) and low-level temperature inversions.

1.8.2 At aerodromes where wind shear is detected by automated, ground-based, wind shear remote-sensing or detection equipment, wind shear alerts generated by these systems are issued (updated at least every minute). Wind shear alerts give concise, up-to-date information related to the observed existence of wind shear involving a headwind/tailwind change of 7.5 m/s (15 kt) or more which could adversely affect aircraft on the final approach path or initial take-off path and aircraft on the runway during the landing roll or take-off run.

1.8.3 In some instances, the systems used for the detection of wind shear have proven utility in wake turbulence detection and tracking/monitoring. This may prove especially beneficial for congested and/or complex aerodromes (e.g. close parallel runways) since ground-based LIDAR at an aerodrome can serve a dual purpose – i.e. wake vortices are an issue when wind shear is not.

1.9 Element 6: SIGMET and other operational meteorological (OPMET) information

1.9.1 Where air traffic services are provided, SIGMET information is issued by a MWO for its associated FIR and/or CTA. SIGMETs are messages that describe the location of specified en-route weather phenomena which may affect the safety of aircraft operations. SIGMETs are required to be issued whenever thunderstorms, turbulence, icing, mountain waves, volcanic ash clouds, tropical cyclones and radioactive clouds occur or are expected to occur in the FIR or CTA at cruising levels (irrespective of altitude). Other forms of OPMET information, including METAR/SPECI and TAF, are issued by aerodrome meteorological offices to provide information on the observed occurrence or expected occurrence of specified meteorological conditions at the aerodrome. Such meteorological conditions include surface wind (speed and direction), visibility, weather, clouds (amount, base and type), temperature (air and dew-point) and atmospheric pressure.

2. Intended Performance Operational Improvement/Metric to determine success

KPAs	Specific improvement provided.
KPA-02: Capacity	Optimized usage of airspace capacity, thus achieving arrival and departure rates. Metric: ACC and aerodrome throughput.
KPA-03: Cost effectiveness	Reduction in costs through reduced arrival and departure delays (viz. reduced fuel burn). Metric: Fuel consumption and associated costs.
KPA-04: Efficiency	Harmonized arriving air traffic (en-route to terminal area to aerodrome) and harmonized departing air traffic (aerodrome to terminal area to en-route) will translate to reduced arrival and departure holding times and thus reduced fuel burn. Metric: Fuel consumption and flight time punctuality.
KPA-05: Environment	Reduced fuel burn through optimized departure and arrival profiling/scheduling. Metric: Fuel burn and emissions.
KPA-06: Flexibility	Supports pre-tactical and tactical arrival and departure sequencing and thus dynamic air traffic scheduling. Metric: ACC and aerodrome throughput.
KPA-07: Global interoperability	Gate-to-gate seamless operations through common access to, and use of, the available WAFS, IAVW and tropical cyclone watch forecast information. Metric: ACC throughput.
KPA-08: Participation by the ATM community	Common understanding of operational constraints, capabilities and needs, based on expected (forecast) meteorological conditions. Metric: Collaborative decision making at the aerodrome and during all phases of flight.
KPA-09: Predictability	Decreased variance between the predicted and actual air traffic schedule. Metric: Block time variability, flight-time error/buffer built into schedules.
KPA-10: Safety	Increased situational awareness and improved consistent and collaborative decision-making. Metric: Incident occurrences.
Cost Benefit Analysis	To be developed

3. Necessary Procedures (Air and Ground)

3.1 No new procedures necessary.

3.2 ICAO Annex 3 – *Meteorological Service for International Air Navigation* provides the internationally agreed requirements pertaining to, *inter alia*, the WAFS, the IAVW, the tropical cyclone watch, and aerodrome warnings, wind shear warnings and alerts, SIGMET information and other OPMET information.

3.3

3.4 Supporting guidance material is contained in a number of ICAO manuals, including but not limited to: *Manual of Aeronautical Meteorological Practice* (Doc 8896); *Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services* (Doc 9377); *Handbook on the International Airways Volcano Watch – Operational Procedures and Contact List* (Doc 9766); and *Manual on Low Level Wind shear* (Doc 9817). In addition, the *Manual on volcanic ash, radioactive material and toxic chemical clouds* (Doc 9691) provides extensive guidance on, *inter alia*, the observation/detection and forecasting of volcanic ash in the atmosphere and the effect of volcanic ash on aircraft.

3.5 ICAO regional air navigation plans contain region-specific requirements pertaining to WAFS, IAVW and tropical cyclone watch information and exchange.

4. Necessary System Capability

4.1 Avionics

4.1.1 No new or additional avionics requirements and brought about by this module.

4.2 Ground systems

4.2.1 ANSPs, airport operators and airspace users may want to implement functionalities allowing them to display in plain text or graphical format the available meteorological information. For Block 0, airspace users may use their AOC data link connection to the aircraft to send the meteorological information where appropriate.

5. Human Performance

5.1 Human factors considerations

5.1.1 General statements on the impact on operational functions.

5.1.1.1 This module will not necessitate significant changes in how air navigation service providers and users access and make use of the available meteorological information today.

5.2 Training and qualification requirements

5.3 No new or additional training and qualification requirements are brought about by this module.

6. Regulatory/standardization needs and Approval Plan (Air and Ground)

6.1 No new or additional regulatory/standardization needs and approval plan(s) are brought about by this module. Provisions relating to the WAFS, the IAVW and the tropical cyclone watch, as well as aerodrome warnings, wind shear warnings and alerts, SIGMET information and other OPMET information already exist within ICAO Annex 3, regional air navigation plans, and supporting guidance.

7. Implementation and Demonstration Activities (As known at the time of writing)

7.1 Current use

7.1.1 The elements of this module are in current use.

7.2 Elements 1 to 3

7.2.1 Information made available by the WAFCs, VAACs and TCACs is available via the ICAO AFS and public Internet as follows:

a) the satellite distribution system for information relating to air navigation (SADIS) second generation (G2) satellite broadcast;

b) the secure SADIS file transfer protocol (FTP) service; and

c) the world area forecast system internet file service (WIFS).

7.2.2 The United Kingdom, as the SADIS provider State, provides a) and b) for authorized users in the ICAO EUR, MID, AFI Regions and Western part of the ASIA Region; whilst the United States, as the WIFS provider State, provides c) for authorized users in the rest of the world.

7.2.3 Authorized access to the SADIS/SADIS FTP and WIFS services is determined by the Meteorological Authority of the State concerned in consultation with the users.

7.2.4 In addition to the above, volcanic ash and tropical cyclone advisory information and other OPMET information in alphanumeric form is available on the ICAO Aeronautical Fixed Telecommunication Network (AFTN).

7.3 Elements 4 and 5:

7.3.1 Aerodrome warnings are in current use at all aerodromes worldwide (except where a State difference is filed).

7.3.2 Dedicated wind shear detection and alerting systems are in current use at aerodromes worldwide where wind shear is considered a factor – for example, Funchal airport in Madeira (Portugal), Hong Kong international airport (Hong Kong, China) and numerous aerodromes in the United States.

7.4 Element 6:

7.4.1 SIGMET information is in current use at flight information regions or control areas where air traffic services are provided.

7.4.2 Other forms of OPMET information (such as METAR/SEPCI and TAF) are in current use at aerodromes where meteorological service is required to support international air navigation.

7.5 Planned or ongoing activities

7.5.1 Enhancement of the international provisions governing the meteorological information provided by the designated Centres within the frameworks of the WAFS, the IAVW and the tropical cyclone watch, and to aerodromes warnings, wind shear warnings and alerts, SIGMET information and other OPMET information undergo periodic review and, where required, amendment, in accordance with standard ICAO procedure.

8. Reference Documents

8.1 Standards

- ICAO and Industry Standards (i.e. MOPS, MASPS, SPRs)
- ICAO and World Meteorological Organization (WMO) international standards for meteorological information (including, content, format, quantity, quality, timeliness and availability)

8.2 Procedures

8.2.1 Documented procedures by States and ANSPs (to be developed).

8.3 Guidance material

- ICAO Manuals, Guidance Material and Circulars. Also any similar industry documents
- ICAO Doc 7192, *Training Manual* - Part F1 – *Meteorology for Air Traffic Controllers and Pilots*
- ICAO Doc 8896, *Manual of Aeronautical Meteorological Practice*
- ICAO Doc 9161, *Manual on Air Navigation Services Economics*
- ICAO Doc 9377, *Manual on Coordination between Air Traffic Services, Aeronautical Information Services and Aeronautical Meteorological Services*
- ICAO Doc 9691, *Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds*
- ICAO Doc 9766, *Handbook on the International Airways Volcano Watch – Operational Procedures and Contact List*
- ICAO Doc 9817, *Manual on Low Level Wind Shear*
- ICAO Doc 9855, *Guidelines on the Use of the Public Internet for Aeronautical Applications*
- *SADIS User Guide*
- Agreement on the Sharing of Costs of the Satellite Distribution System for Information relating to Air Navigation

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Module N° B0-*FRTO*: Improved Operations through Enhanced En-Route Trajectories

<table>
<tr><td>Summary</td><td colspan="2">To allow the use of airspace which would otherwise be segregated (i.e. special use airspace) along with flexible routing adjusted for specific traffic patterns. This will allow greater routing possibilities, reducing potential congestion on trunk routes and busy crossing points, resulting in reduced flight length and fuel burn.</td></tr>
<tr><td>Main performance impact as per Doc 9883</td><td colspan="2">KPA-01 – Access & Equity, KPA-02 – Capacity, KPA-04 – Efficiency, KPA-05 – Environment, KPA-06 – Flexibility, KPA-09 – Predictability.</td></tr>
<tr><td>Operating environment/ Phases of flight</td><td colspan="2">En-route, TMA</td></tr>
<tr><td>Applicability considerations</td><td colspan="2">Applicable to en-route and terminal airspace. Benefits can start locally. The larger the size of the concerned airspace the greater the benefits, in particular for flex track aspects. Benefits accrue to individual flights and flows.

Application will naturally span over a long period as traffic develops. Its features can be introduced starting with the simplest ones.</td></tr>
<tr><td>Global concept component(s) as per Doc 9854</td><td colspan="2">AOM – airspace organization and management
AUO – airspace users operations
DCB – demand and capacity balancing</td></tr>
<tr><td>Global plan initiatives (GPI)</td><td colspan="2">GPI-1: Flexible use of airspace
GPI-4: Align upper airspace classifications
GPI-7: Dynamic and flexible airspace route management
GPI-8: Collaborative airspace design and management</td></tr>
<tr><td>Main dependencies</td><td colspan="2">NIL</td></tr>
<tr><td rowspan="6">Global readiness checklist</td><td></td><td>Status (ready now or estimated date)</td></tr>
<tr><td>Standards readiness</td><td>✓</td></tr>
<tr><td>Avionics availability</td><td>✓</td></tr>
<tr><td>Ground systems availability</td><td>✓</td></tr>
<tr><td>Procedures available</td><td>✓</td></tr>
<tr><td>Operations approvals</td><td>✓</td></tr>
</table>

1. Narrative

1.1 General

1.1.1 In many areas, flight routings offered by air traffic services (ATS) are static and are slow to keep pace with the rapid changes of users operational demands, especially for long-haul city-pairs. In certain parts of the world, legacy regional route structures have become outdated and are becoming constraining factors due to their inflexibility.

1.1.2 The navigational capabilities of modern aircraft make a compelling argument to migrate away from the fixed route structure towards a more flexible alternative. Constantly changing upper winds have a direct influence on fuel burn and, proportionately, on the carbon footprint. Therein lies the benefit of daily flexible routings. Sophisticated flight planning systems in use at airlines now have the capability to predict and validate optimum daily routings. Likewise, ground systems used by ATS have significantly improved their communication, surveillance and flight data management capabilities.

1.1.3 Using what is already available on the aircraft and within air traffic control (ATC) ground systems, the move from fixed to flex routes can be accomplished in a progressive, orderly and efficient manner.

1.2 **Baseline**

1.2.1 The baseline for this module is varying from a State/region to the next. However, while some aspects have already been the subject of local improvements, the baseline generally corresponds to an airspace organisation and management function which is at least in part characterized by: individual State action, fixed route network, permanently segregated areas, conventional navigation or limited use of area navigation (RNAV), rigid allocation of airspace between civil and military authorities. Where it is the case, the integration of civil and military ATS has been a way to eliminate some of the issues, but not all.

1.3 **Change brought by the module**

1.3.1 This module is aimed at improving the profiles of flights in the en-route phase through the deployment and full application of procedures and functionalities on which solid experience is already available, but which have not been systematically exploited and which are of a nature to make better use of the airspace.

1.3.2 The module is the opportunity to exploit performance-based navigation (PBN) capabilities in order to eliminate design constraints and operate more flexibly, while facilitating the overall handling of traffic flows.

1.3.3 The module is made of the following elements:

a) airspace planning: possibility to plan, coordinate and inform on the use of airspace. This includes collaborative decision-making (CDM) applications for en-route airspace to anticipate on the knowledge of the airspace use requests, take into account preferences and inform on constraints;

b) flexible use of airspace (FUA) to allow both the use of airspace otherwise segregated, and the reservation of suitable volumes for special usage; this includes the definition of conditional routes; and

c) flexible routing (flex tracking): route configurations designed for specific traffic pattern.

1.3.4 This module is a first step towards more optimized organisation and management of the airspace but which would require more sophisticated assistance. Initial implementation of PBN, RNAV for example, takes advantage of existing ground technology and avionics and allows extended collaboration of air navigation service providers (ANSPs) with partners: military, airspace users, neighbouring States.

1.4 **Element 1: Airspace planning**

1.4.1 Airspace planning entails activities to organize and manage airspace prior to the time of flight. Here it more specifically refers to activities to improve the strategic design by a series of measures to better know the anticipated use of the airspace and adjust the strategic design by pre-tactical or tactical actions.

1.5 **Element 2: Flexible use of airspace (FUA)**

1.5.1 Flexible use of airspace is an airspace management concept according to which airspace should not be designated as either purely civil or purely military airspace, but should be considered as one continuum in which all users' requirements have to be accommodated to the maximum extent possible. There are activities which require the reservation of a volume of airspace for their exclusive or specific use for determined periods, owing to the characteristics of their flight profile or their hazardous attributes and the need to ensure effective and safe separation from non-participating air traffic. Effective and harmonized application of FUA needs clear and consistent rules for civil/military coordination which should take into account all users' requirements and the nature of their various activities. Efficient civil/military coordination procedures should rely on rules and standards to ensure efficient use of airspace by all users. It is essential to further cooperation between neighbouring States and to take into account cross border operations when applying the concept of FUA.

1.5.2 Where various aviation activities occur in the same airspace but meet different requirements, their coordination should seek both the safe conduct of flights and the optimum use of available airspace.

1.5.3 Accuracy of information on airspace status and on specific air traffic situations and timely distribution of this information to civil and military controllers has a direct impact on the safety and efficiency of operations.

1.5.4 Timely access to up-to-date information on airspace status is essential for all parties wishing to take advantage of airspace structures made available when filing or re-filing their flight plans.

1.5.5 The regular assessment of airspace use is an important way of increasing confidence between civil and military service providers and users and is an essential tool for improving airspace design and airspace management.

1.5.6 FUA should be governed by the following principles:

a) coordination between civil and military authorities should be organized at the strategic, pre-tactical and tactical levels of airspace management through the establishment of agreements and procedures in order to increase safety and airspace capacity, and to improve the efficiency and flexibility of aircraft operations;

b) consistency between airspace management, air traffic flow management and air traffic services should be established and maintained at the three levels of airspace management in order to ensure, for the benefit of all users, efficiency in airspace planning, allocation and use;

c) the airspace reservation for exclusive or specific use of categories of users should be of a temporary nature, applied only during limited periods of time-based on actual use and released as soon as the activity having caused its establishment ceases;

d) States should develop cooperation for the efficient and consistent application of the concept of FUA across national borders and/or the boundaries of flight information regions, and should in particular address cross-border activities; this cooperation shall cover all relevant legal, operational and technical issues; and

e) ATS units and users should make the best use of the available airspace.

1.6 Element 3: Flexible routing

1.6.1 Flexible routing is a design of routes (or tracks) designed to match the traffic pattern and other variable factors such as meteorological conditions. The concept, used over the North-Atlantic since decades can be expanded to address seasonal or week end flows, accommodate special events, and in general better fit the meteorological conditions, by offering a set of routes which provide routings closer to the user preferences for the traffic flows under consideration.

1.6.2 When already in place, flex tracks systems can be improved in line with the new capabilities of ATM and aircraft, such as PBN and automatic dependent surveillance (ADS).

1.6.3 A current application of the element is the dynamic air route planning system (DARPS), used in the Pacific Region with flexible tracks and reduced horizontal separation to 30 NM using RNP 4 and ADS and controller pilot data link communications (CPDLC).

1.6.4 Convective meteorological conditions, particularly deep convection associated with towering cumulus and/or cumulonimbus clouds, causes many delays in today's system due to their hazardous nature (severe icing, severe turbulence, hail, thunderstorms, etc.), often-localized nature and the labour intensive voice exchanges of complex reroutes during the flight. New data communications automation will enable significantly faster and more efficient delivery of reroutes around such convective activity. This operational improvement will expedite clearance delivery resulting in reduced delays and miles flown during convective meteorological conditions.

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).

Access and Equity	Better access to airspace by a reduction of the permanently segregated volumes.
Capacity	The availability of a greater set of routing possibilities allows reducing potential congestion on trunk routes and at busy crossing points. The flexible use of airspace gives greater possibilities to separate flights horizontally. PBN helps to reduce route spacing and aircraft separations. This in turn allows reducing controller workload by flight.
Efficiency	The different elements concur to trajectories closer to the individual optimum by reducing constraints imposed by permanent design. In particular the module will reduce flight length and related fuel burn and emissions. The potential savings are a significant

	proportion of the ATM related inefficiencies. The module will reduce the number of flight diversions and cancellations. It will also better allow avoiding noise sensitive areas.
Environment	Fuel burn and emissions will be reduced; however, the area where emissions and contrails will be formed may be larger.
Flexibility	The various tactical functions allow reacting rapidly to changing conditions.
Predictability	Improved planning allows stakeholders to anticipate on expected situations and be better prepared.
Cost Benefit Analysis	Element 2: FUA As an example, over half of the United Arab Emirates (UAE) airspace is military. Currently, civil traffic is concentrated on the northern portion of the UAE. Opening up this airspace could potentially enable yearly savings in the order of: b) 4.9 million litres of fuel; and c) 581 flight hours. In the U.S. a study for NASA by Datta and Barington showed maximum savings of dynamic use of FUA of $7.8M (1995 $). Element 3: Flexible routing. Early modelling of flexible routing suggests that airlines operating a 10-hour intercontinental flight can cut flight time by six minutes, reduce fuel burn by as much as 2% and save 3,000 kilograms of CO2 emissions. These improvements in efficiency directly help the industry in meeting its environmental targets. Some of the benefits that have accrued from flex route programmes in sub-region flows include: a) reduced flight operating costs (1% to 2% of operating costs on long-haul flights); b) reduced fuel consumption (1% to 2% on long-haul flights); c) more efficient use of airspace (access to airspace outside of fixed airway structure); d) more dynamic flight planning (airlines able to leverage capability of sophisticated flight planning systems); e) reduced carbon footprint (reductions of over 3,000 kg of CO2 on long-haul flights); f) reduced controller workload (aircraft spaced over a wider area); and g) increased passenger and cargo capacity for participating flights (approximately 10 extra passengers on long-haul flights).

Comparison of Flight Time and Fuel Burn using Fixed and Flex Routes using Sao Paulo-Dubai flights throughout the year 2010 (Source: IATA iFLEX Preliminary Benefit Analysis)

In the U.S. RTCA NextGen Task Force Report, it was found that benefits would be about 20% reduction in operational errors; 5-8% productivity increase (near term; growing to 8-14% later); capacity increases (but not quantified). Annual operator benefit in 2018 of $39,000 per equipped aircraft (2008 dollars) growing to $68,000 per aircraft in 2025 based on the FAA Initial investment Decision. For the high throughput, high capacity benefit case (in 2008 dollars): total operator benefit is $5.7B across programme lifecycle (2014-2032, based on the FAA initial investment decision).

3. Necessary Procedures (Air and Ground)

3.1 Required procedures exist for the main. They may need to be complemented by local practical guidance and processes; however, the experience from other regions can be a useful reference source to be customized to the local conditions.

3.2 The development of new and/or revised ATM procedures is automatically covered by the definition and development of listed elements. However, given the interdependencies between some of the modules, care needs to be taken so that the development of the required ATM procedures provides for a consistent and seamless process across these modules.

3.3 The airspace requirements (RNAV, RNP and the value of the performance required) may require new ATS procedures and ground system functionalities. Some of the ATS procedures required for this module are linked with the processes of notification, coordination and transfer of control, supported by messages exchange (Module B*0-FICE*).

3.4 Element 1: Airspace planning

3.4.1 See general remarks above.

3.5 Element 2: FUA

3.5.1 The ICAO *Civil/Military Cooperation in Air Traffic Management* (Cir 330) offers guidance and examples of successful practices of civil and military cooperation. It realizes that successful cooperation requires collaboration that is based on communication, education, a shared relationship and trust.

3.6 Element 3: Flexible routing

3.6.1 A number of operational issues and requirements will need to be addressed to enable harmonized deployment of flex route operations in a given area such as:

a) some adaptation of letters of agreement;

b) revised procedures to consider the possibility of transfer of control at other than published fixes;

c) use of latitude/longitude or bearing and distance from published fixes, as sector or flight information region (FIR) boundary crossing points;

d) review of controller manuals and current operating practices to determine what changes to existing practices will need to be developed to accommodate the different flows of traffic which would be introduced in a flex route environment;

e) specific communication and navigation requirements for participating aircraft will need to be identified;

f) developing procedures that will assist ATC in applying separation minima between flights on the fixed airway structure and flex routes both in the strategic and tactical phases;

g) procedure to cover the transition between the fixed network and the flex route airspace both horizontally and vertically. In some cases, a limited time application (e.g. during night) of flex route operations could be envisaged. This will require modification of ATM procedures to reflect the night traffic patterns and to enable the transition between night flex route operations and daytime fixed airway operations; and

h) training package for ATC.

4. Necessary System Capability

4.1 Avionics

4.1.1 Deployment of PBN is ongoing. The benefits provided to flights can facilitate its dissemination, but it will remain linked to how aircraft can fly.

4.1.2 Dynamic re-routing can require aircraft connectivity (Aircraft communication addressing and reporting system (ACARS)) to its flight operating centre for flight tracking and the up-load of new routes computed by the FOC flight planning system (FPS), and possibly FANS 1/A capability for the exchange of clearance with ATC.

4.2 Ground systems

4.2.1 Technology is available. Even CDM can be supported by a form of internet portal. However, since aviation operations are global, standardization of the information and its presentation will be increasingly required (see thread 30 on SWIM).

4.2.2 Basic FUA concept can be implemented with the existing technology. Nevertheless for a more advanced use of conditional routes, a robust collaborative decision system will be required including function for the processing and display of flexible or direct routes containing latitude/longitude. In addition to published fixes a coordination function is also needed and may need specific adaptations to support transfer of control over non published points.

4.2.3 Enhanced FPS today are predicated on the determination of the most efficient flight profile. The calculations of these profiles can be driven by cost, fuel, time, or even a combination of the factors. All airlines deploy FPS at different levels of sophistication and automation in order to assist flight dispatchers/planners to verify, calculate and file flight plans.

4.2.4 Additionally, the flight dispatcher would need to ensure the applicability of over-flight permissions for the over-flown countries. Regardless of the route calculated, due diligence must always be exercised by the airline in ensuring that NOTAMs and any restrictive flight conditions will always be checked and validated before a flight plan is filed. Further, most airlines are required to ensure a flight following or monitoring program to update the crews with any changes in the flight planning assumptions that might have changed since the first calculation was made.

5. Human Performance

5.1 Human factors considerations

5.1.1 The roles and responsibilities of controller/pilot are not affected. However, 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 failures 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 The required training is available and the change step is achievable from a human factors perspective. Training in the operational standards and procedures are required for this module and can be found in the links to the documents in Section 8 to this module. Likewise, the qualifications requirements are identified in the regulatory requirements in Section 6 which form an integral part to the implementation of this module.

6. Regulatory/standardisation needs and Approval Plan (Air and Ground)

- Regulatory/standardization: use current published requirements that include the material give in Section 8.4.

- Approval plans: to be determined, based upon regional applications. Possible regional mandates of PBN should be considered.

6.1 Element 1: Airspace planning

6.1.1 See general remarks above.

6.2 Element 2: FUA

6.2.1 Until today, the Article 3 of the Chicago Convention expressly excludes the consideration of State aircraft from the scope of applicability.

6.2.2 Exemption policies for specific State aircraft operations and services are currently used as a method to cope with the discrepancy of civil and military aviation needs. Some States already realize that for State aircraft a solution lays in an optimum compatibility to civil aviation, although military requirements have to be met.

6.2.3 ICAO provisions related to coordination between civil and military in support to the flexile use of airspace can be found in several annexes, PANS and manuals.

6.2.4 Annex 11 — *Air Traffic Services* allows States to delegate responsibility for the provision of ATS to another State. However, States retain sovereignty over the airspace so delegated, as confirmed by their adherence to the Chicago Convention. This factor may require additional effort or coordination in relation to civil/military cooperation and an appropriate consideration in bilateral or multilateral agreements.

6.3 Element 3: Flexible routing

6.3.1 LoA/LoCs: Letters of agreement (LoA) and/or letters of coordination (LoC) might be required to reflect the specificities of flex route operations. Local hand-off procedures, timings and frequency allocations must be clearly detailed. Allocation schemes are also useful in designing major unidirectional flows, such as the EUR-Caribbean flows.

6.4 Common enabler: PBN procedures

6.4.1 Within an airspace concept, PBN requirements will be affected by the communication, surveillance and ATM environments, the navaid infrastructure, and the functional and operational capabilities needed to meet the ATM application. PBN requirements also depend on what reversionary, non-RNAV means of navigation are available and what degree of redundancy is required to ensure adequate continuity of functions.

6.4.2 The selection of the PBN specification(s) for a specific area or type of operation has to be decided in consultation with the airspace users. Some areas need only a simple RNAV to maximize the benefits, while other areas such as nearby steep terrain or dense air traffic may require the most stringent RNP. International public standards for PBN are still evolving. International PBN is not widespread. According to the ICAO/IATA Global PBN Task Force, international air traffic management and state flight standards rules and regulations lag behind airborne capability.

6.4.3 There is a need for worldwide harmonization of RNP requirements, standards, procedures and practices, and common flight management system functionality for predictable and repeatable RNP procedures, such as fixed radius transitions, radius-to-fix legs, required time of arrival (RTA), parallel offset, VNAV, 4D control, ADS-B, data link, etc.

6.4.4 A safety risk management document may be required for every new or amended procedure. That requirement will extend the time required to implement new procedures, especially PBN-based flight procedures.

7. Implementation and Demonstration Activities (as known at time of writing)

7.1 Current use

7.1.1 Most of the proposed elements have already been implemented in at least a region.

7.1.2 In particular, one will note the following realizations which can be taken as examples of how to achieve the module.

7.2 Element 1: Airspace planning

- **Europe**: Airspace planning is implemented in European States with airspace management cells, and at European scale through the network operations plan (NOP) which provide advanced notice on the (de)-activation of segregated airspace and conditional routes.

- **LARA:** LARA (local and subregional airspace management support system) is an initiative aimed at improving performance-based airspace management (ASM).

  LARA provides a software application to support ASM. It is focused on automation at local and regional levels for civil-military and military-military coordination. It is intended to provide a more efficient and transparent decision-making process between civil and military stakeholders for ATM performance enhancement. It will also provide information for civil-military coordination at network level to support the MILO function (military liaison officer function at central flow management unit (CFMU)). The LARA application will support the following:

a) airspace planning: to manage airspace bookings; to incorporate air traffic flow and capacity management (ATFCM) data into the airspace planning process; to facilitate the analysis and creation of a national/regional airspace plan; to assess network scenario proposals and to facilitate coordination for decision-making on a national level;

b) airspace status: to provide real-time, airspace common situation awareness; and

c) statistics: in collating airspace data and measuring airspace utilization through meaningful civil-military key performance indicators (KPIs), LARA will archive the data for further analysis.

A demonstrator was developed and successfully tested in January 2008. In 2009 LARA first prototype and various incremental versions based on it were delivered. Support to a functional airspace block Europe central (FABEC) trial has been initiated.

7.3 Element 2: Flexible use of airspace (FUA)

7.3.1 FUA has been implemented in Europe in the 90s and regularly improved on an as-needed basis. It leans on the airspace planning features described above, and coordination mechanisms to address the tactical coordination actions.

7.3.2 Collaboration decision-making (CDM) is implemented in the US NASCSC.

7.4 Element 3: Flexible routing

- **North-Atlantic**: Implemented with two daily sets of organized track systems

- **Japan**: Coordination of airspace use: In the coordination of rerouting for avoidance of airspace capacity saturation or hazardous meteorological conditions, air traffic management control (ATMC) and airline operators share and use the “rerouting list” of the flight routes between city pairs, which has been established and updated after making the necessary coordination with airline operators and ATC facilities. Using the rerouting list makes coordination simple and the coordination is effective to decrease the demand of the congesting airspace and to identify the variation of air traffic flow. The major airline operators are able to coordinate by ATM workstations. ATMC coordinates usage of the areas for IFRs flights with the military liaison officers, and then IFRs flights are able to fly through the segregated areas following ATC instructions. Also taking into account requirements for which IFRs flights enter the certain segregated area for avoiding adverse weather, ATMC is able to coordinate with military liaison officers for using military training/testing areas temporarily.

- **IATA**: IATA in conjunction with Emirates Airlines and Delta Airlines proposes to conduct a proof of concept of Flex Route capability on the Dubai – Sao Paulo and Atlanta – Johannesburg city-pairs respectively. The goal of the proof of concept trial is to gather performance data, measure tangible results and identify areas where mitigation may be required to address operational, procedural, and technical issues. Dependent on the results of the proof of concept trial, an operational trial with broader participation may be initiated in the future. This will allow airlines and ANSPs to take advantage of past experience and provide valuable guidance on what can be achieved, as they seek to implement flexible routing.

- **United States**: FAA published a number of PBN procedures to deliver more direct routes, saving time and fuel and reducing emissions. Specifically, the FAA published fifty required RNP authorization required and published 12 RNAV routes.

  Alaska Airlines is saving more than 217 flight miles per day and nearly 200,000 gallons of fuel per year by using parallel flight routes, or Q routes, between Seattle, Portland and Vancouver on one end, and airports in the San Francisco Bay and Los Angeles basin areas on the other. The initial parallel routes were developed in 2004 in partnership with the FAA.

- **Oceanic areas**: Pacific Region: Dynamic air route planning system (DARPS), used with flexible tracks and reduced horizontal separation to 30 NM using RNP 4 and automatic dependent surveillance (ADS) and controller pilot data link communications (CPDLC).

7.5 Planned or ongoing activities

- **Asia and South Pacific** initiative to reduce emissions (ASPIRE)

  Using advanced technologies and oceanic procedures (ATOP) conflict probe capabilities and improved communications techniques with the operators, a limited number of oceanic trajectory optimization demonstration flights were performed in 2008 in partnership with Air Europa. These demonstrations resulted in fuel savings of 0.5 percent-1 percent, validating the concept. During 2009, the additional partners participated in 119 oceanic optimization flights over the Atlantic. According to initial data analysis, the estimated fuel savings from re-routings on these flights averaged 1.4 per cent, equivalent to about 230 gallons of fuel and more than 2 tons of carbon dioxide reductions per flight.

  The 2008-09 demonstrations were limited to westbound routes and lateral rerouting. In 2010, the lateral reroute procedures tests continued, and the FAA initiated investigations on the benefits of vertical rerouting and eastbound routes. In addition, automatic dependent surveillance-contract climb and descent procedures were conducted in an operational trial over the Pacific Ocean to examine a reduction in oceanic separation from 30 to 15 miles, in an effort to better accommodate more efficient and user-preferred routes.

  The ASPIRE initiative was launched in 2008 by the United States, Australia and New Zealand. Japan joined it in October 2009 and Singapore in January 2010. United Airlines, Qantas and Air New Zealand flew the original demonstrations. Japan Airlines' first demonstration flight, a Boeing 747 operating from Honolulu to Osaka, explored NextGen concepts such as user-preferred route and dynamic airborne rerouting capabilities, plus a number of weight- and energy-saving techniques. In gate-to-gate demonstrations of emissions reduction on transpacific routes, the average fuel saving during en route operations was 2.5 percent.

  In its annual report for 2009, issued before Japan joined, ASPIRE estimated that if all 156 transpacific flights per week between Australia, New Zealand, the United States and Canada operated under conditions adopted for its demonstrations, airlines would save more than

10 000 000 gallons of fuel and avoid more than 100 000 tons of carbon emissions per year. Air New Zealand in October 2009 cited ASPIRE as a significant contributor to a fuel saving of 10 per cent and a reduction of more than 385,000 tons of carbon emissions in its 2009 financial year compared with the previous year.

- **Dynamic airborne reroute procedure (DARP)**

  Flights take advantage of the six hourly update of the upper air wind and temperature forecast to effectively re-plan the flight en-route through a procedure called a DARP. This process can be completed as forecasts become available. Use of DARP commences with an aircraft data link request for a DARP to the Air New Zealand Flight Dispatch Office in Auckland. Immediately the latest wind/temperature forecast becomes available, the flight dispatch officer recalculates the optimum track from a predetermined point just ahead of the current aircraft airborne position. Once calculated the revised route is uplinked to the aircraft for the crew to consider. The crew then downlink a request for the revised route to the Oceanic control centre and once approved, accept the revised route into the active side of the flight management computer (FMC). Savings vary greatly from day to day dependent on the accuracy of the original forecast, the average AKL-SFO flight would save 70 US gallons.

8. Reference Documents

8.1 Standards

- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*, Chapter 5

8.2 Guidance material

- ICAO Doc 9426, *Air Traffic Services Planning Manual*
- ICAO Doc 9554, *Manual Concerning Safety Measures Relating to Military Activities Potentially Hazardous to Civil Aircraft Operations*
- ICAO Doc 9613, *Performance-based Navigation (PBN) Manual*
- ICAO Doc 9689, *Manual on Airspace Planning Methodology for the Determination of Separation Minima*
- ICAO CDM and ATFM (under development) Manual
- ICAO Circular 330 AN/189, *Civil/Military Cooperation in Air Traffic Management*

8.3 Approval documents

- ICAO Doc 9426, *Air Traffic Services Planning Manual*
- ICAO Doc 9689, *Manual on Airspace Planning Methodology for the Determination of Separation Minima*
- ICAO Doc 9613, *Performance-based Navigation (PBN) Manual*
- ICAO Doc 9554, *Manual Concerning Safety Measures Relating to Military Activities Potentially Hazardous to Civil Aircraft Operations*
- ICAO Circular 330 AN/189, *Civil/Military Cooperation in Air Traffic Management*

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Module N° B*0-CDO*: Improved Flexibility and Efficiency in Descent Profiles (CDO)

<table>
<tr><td>Summary</td><td colspan="2">To use performance-based airspace and arrival procedures allowing aircraft to fly their optimum profile using continuous descent operations (CDOs). This will optimize throughput, allow fuel efficient descent profiles and increase capacity in terminal areas.</td></tr>
<tr><td>Main performance impact as per Doc 9883</td><td colspan="2">KPA-04 – Efficiency, KPA-05 – Environment, KPA-09 – Predictability, KPA-10 – Safety.</td></tr>
<tr><td>Operating environment/ Phases of flight</td><td colspan="2">Approach/arrivals and en-route.</td></tr>
<tr><td>Applicability considerations</td><td colspan="2">Regions, States or individual locations most in need of these improvements. For simplicity and implementation success, complexity can be divided into three tiers:
a) least complex – regional/States/locations with some foundational PBN operational experience that could capitalize on near term enhancements, which include integrating procedures and optimizing performance;
b) more complex – regional/States/locations that may or may not possess PBN experience, but would benefit from introducing new or enhanced procedures. However, many of these locations may have environmental and operational challenges that will add to the complexities of procedure development and implementation; and
c) most complex – regional/States/locations in this tier will be the most challenging and complex to introduce integrated and optimized PBN operations. Traffic volume and airspace constraints are added complexities that must be confronted. Operational changes to these areas can have a profound effect on the entire State, region or location.</td></tr>
<tr><td>Global concept component(s) as per Doc 9854</td><td colspan="2">AOM – airspace organization and management AO – aerodrome operations
TS – traffic synchronization, AOM</td></tr>
<tr><td>Global plan initiatives (GPI)</td><td colspan="2">GPI-10: Terminal area design and management
GPI-11: RNP and RNAV standard instrument departures (SIDS) and standard terminal arrivals (STARS)</td></tr>
<tr><td>Main dependencies</td><td colspan="2">Nil</td></tr>
<tr><td rowspan="6">Global readiness checklist</td><td></td><td>Status (ready now or estimated date).</td></tr>
<tr><td>Standards readiness</td><td>√</td></tr>
<tr><td>Avionics availability</td><td>√</td></tr>
<tr><td>Ground system availability</td><td>√</td></tr>
<tr><td>Procedures available</td><td>√</td></tr>
<tr><td>Operations approvals</td><td>√</td></tr>
</table>

1. Narrative

1.1 General

1.1.1 This module integrates with other airspace and procedures (continuous descent operations (CDO), performance-based navigation (PBN) and airspace management) to increase efficiency, safety, access and predictability.

1.1.2 As traffic demand increases, the challenges in terminal areas centre on volume, hazardous meteorological conditions (such as severe turbulence and low visibility), adjacent airports and special activity airspace in close proximity whose procedures utilize the same airspace, and policies that limit capacity, throughput, and efficiency.

1.1.3 Traffic flow and loading (across ingress and egress routes) are not always well-metered, balanced or predictable. Obstacle and airspace avoidance (in the form of separation minima and criteria), noise abatement procedures, as well as wake encounter risk mitigation, tend to result in operational inefficiencies (e.g. added time or distance flown, thus more fuel).

1.1.4 Inefficient routing can also cause under-use of available airfield and airspace capacity. Finally, challenges are presented to States by serving multiple customers (international and domestic with various capabilities): the intermingling of commercial, business, general aviation and many times military traffic destined to airports within a terminal area that interact and at times inhibit each other's operations.

1.2 Baseline

1.2.1 The baseline for this module may vary from one State, region or location to the next. Noted is the fact that some aspects of the movement to PBN have already been the subject of local improvements in many areas; and these areas and users are already realizing benefits.

1.2.2 The lack of ICAO PBN operational approval guidance material is slowing down implementation and is perceived as one of the main roadblocks for harmonization.

1.2.3 There is still some work to be done to harmonize PBN nomenclature, especially in charts and States/regional regulations (e.g. most of European regulations still mention basic area navigation (B-RNAV) and precision area navigation (P-RNAV).

1.3 Change brought by the module

1.3.1 Flight operations in many terminal areas precipitate the majority of current airspace delays in many States. Opportunities to optimize throughput, improve flexibility, enable fuel-efficient climb and descent profiles, and increase capacity at the most congested areas should be a high-priority initiative in the near-term.

1.3.2 The core capabilities that should be leveraged are RNAV; RNP where needed; CDO; where possible, increased efficiencies in terminal separation rules in airspace; effective airspace design and classification; air traffic control (ATC) flow and ATC surveillance. Opportunities to reduce emissions and aircraft noise impacts should also be leveraged where possible.

1.4 Element 1: Continuous descent operations

1.4.1 Continuous descent is one of several tools available to aircraft operators and ANSPs to benefit from existing aircraft capabilities and reduce noise, fuel burn and the emission of greenhouse gases. Over the years, different route models have been developed to facilitate CDO and several attempts have been made to strike a balance between the ideal of environmentally friendly procedures and the requirements of a specific airport or airspace.

1.4.2 CDO can provide for a reduction in fuel burn and emissions, while increasing flight stability and the predictability of flight path to both controllers and pilots, without compromising the optimal airport arrival rate (AAR).

1.4.3 CDO is enabled by airspace design, procedure design and facilitation by ATC, in which an arriving aircraft descends continuously, to the greatest possible extent, by employing minimum engine thrust, ideally in a low drag configuration, prior to the final approach fix/final approach point (FAF/FAP). An optimum CDO starts from the top-of-descent (TOD) and uses descent profiles that reduce controller-pilot communications and segments of level flight.

1.4.4 Furthermore it provides for a reduction in noise, fuel burn and emissions, while increasing flight stability and the predictability of flight path to both controllers and pilots.

1.5 Element 2: Performance-based navigation

1.5.1 PBN is a global set of area navigation standards, defined by ICAO, based on performance requirements for aircraft navigating on departure, arrival, approach or en-route.

1.5.2 These performance requirements are expressed as navigation specifications in terms of accuracy, integrity, continuity, availability and functionality required for a particular airspace or airport.

1.5.3 PBN will eliminate the regional differences of various required navigation performance (RNP) and area navigation (RNAV) specifications that exist today. The PBN concept encompasses two types of navigation specifications:

a) RNAV specification: navigation specification-based on area navigation that does not include the requirement for on-board performance monitoring and alerting, designated by the prefix RNAV, e.g. RNAV 5, RNAV 1; and

b) RNP specification: navigation specification based on area navigation that includes the requirement for on-board performance monitoring and alerting, designated by the prefix RNP, e.g. RNP 4.

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).

Efficiency	• Cost savings and environmental benefits through reduced fuel burn. • Authorization of operations where noise limitations would otherwise result in

	operations being curtailed or restricted. • Reduction in the number of required radio transmissions. • Optimal management of the top-of-descent in the en-route airspace.
Environment	As per efficiency
Predictability	• More consistent flight paths and stabilized approach paths. • Less need for vectors.
Safety	• More consistent flight paths and stabilized approach paths. • Reduction in the incidence of controlled flight into terrain (CFIT). • Separation with the surrounding traffic (especially free-routing). • Reduction in the number of conflicts.
Cost Benefit Analysis	The following savings are an example of potential savings as a result of CDO implementation. *It is important to consider that CDO benefits are heavily dependent on each specific ATM environment.* Nevertheless, if implemented within the ICAO CDO manual framework, it is envisaged that the benefit/cost ratio (BCR) will be positive. Example of savings after CDO implementation in Los Angeles TMA (KLAX): a) CDOs RIIVR2/SEAVU2/OLDEE1 and 4 ILS: 1) implemented 25 September 2008, and in use full time at KLAX; b) about 300 - 400 aircraft per day fly RIIVR2/SEAVU2/OLDEE1 STARs representing approximately half of all jet arrivals into KLAX: 1) fifty per cent reduction in radio transmissions; and c) significant fuel savings – average 125 pounds per flight. 1) 300 flights/day * 125 pounds per flight * 365 days = 13.7 million pounds/year; and 2) more than 2 million gallons/year saved = more than 41 million pounds of CO2 emission avoided. The advantage of PBN to the ANSP is that PBN avoids the need to purchase and deploy navigation aids for each new route or instrument procedure. The advantage to everyone is that PBN clarifies how area navigation systems are used and facilitates the operational approval process for operators by providing a limited set of navigation specifications intended for global use. The safety benefits to PBN are significant, as even airports located in the poorest areas of the world can have runway aligned approaches with horizontal and vertical guidance to any runway end without having to install, calibrate and monitor expensive ground-based navigation aids. Therefore, with PBN all airports can have a stabilized instrument approach that will allow aircraft to land into the wind, as opposed to a tail wind landing.

3. Necessary Procedures (Air and Ground)

3.1 The ICAO *Continuous Descent Operations (CDO) Manual* (Doc 9931) provides guidance on the airspace design, instrument flight procedures, ATC facilitation and flight techniques necessary to enable continuous descent profiles.

3.2 It therefore provides background and implementation guidance for:

a) air navigation service providers (ANSPs);

b) aircraft operators;

c) airport operators; and

d) aviation regulators.

3.3 The ICAO *Performance-based Navigation (PBN) Manual* (Doc 9613) provides general guidance on PBN implementation. This manual identifies the relationship between RNAV and RNP applications and the advantages and limitations of choosing one or the other as the navigation requirement for an airspace concept.

3.4 It also aims at providing practical guidance to States, ANSPs and airspace users on how to implement RNAV and RNP applications, and how to ensure that the performance requirements are appropriate for the planned application.

3.5 The management of the top-of-descent (TOD) with CDO in en-route airspace (especially in the context of free-routing) will have to be analyzed because CDO will imply an imposed TOD.

4. Necessary System Capability

4.1 Avionics

4.1.1 CDO is an aircraft operating technique aided by appropriate airspace and procedure design and appropriate ATC clearances enabling the execution of a flight profile optimized to the operating capability of the aircraft, with low engine thrust settings and, where possible, a low drag configuration, thereby reducing fuel burn and emissions during descent.

4.1.2 The optimum vertical profile takes the form of a continuously descending path, with a minimum of level flight segments only as needed to decelerate and configure the aircraft or to establish on a landing guidance system (e.g. ILS).

4.1.3 The optimum vertical path angle will vary depending on the type of aircraft, its actual weight, the wind, air temperature, atmospheric pressure, icing conditions and other dynamic considerations.

4.1.4 A CDO can be flown with or without the support of a computer-generated vertical flight path (i.e. the vertical navigation (VNAV) function of the flight management system (FMS)) and with or without a fixed lateral path. However, the maximum benefit for an individual flight is achieved by keeping the aircraft as high as possible until it reaches the optimum descent point. This is most readily determined by the onboard FMS.

4.2 Ground systems

4.2.1 Within an airspace concept, PBN requirements will be affected by the communication, surveillance and ATM environments, the NAVAID infrastructure and the functional and operational capabilities needed to meet the ATM application.

4.2.2 PBN performance requirements also depend on what reversionary, non-RNAV means of navigation are available and what degree of redundancy is required to ensure adequate continuity of functions. Ground automation needs initially little changes to support CDO: potentially a flag on the display. For better integration the ground trajectory calculation function will need to be upgraded.

5. Human Performance

5.1 Human factors considerations

5.1.1 The decision to plan for RNAV or RNP has to be decided on a case by case basis in consultation with the airspace user. Some areas need only a simple RNAV to maximize the benefits, while other areas such as nearby steep terrain or dense air traffic may require the most stringent RNP.

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 (see Section 6 for examples). The possibility of latent failures however, continues to exist and vigilance is requested during all implementation actions. It is further requested that human factor issues, identified during implementation, are reported to the international community through ICAO as part of any safety reporting initiative.

5.2 Training and qualification requirements

5.2.1 Since required navigation performance authorization required (RNP AR) approaches also require significant training, ANSPs should work closely with airlines to determine where RNP AR approach should be implemented. In all cases PBN implementation needs to be an agreement between the airspace user, the ANSP and the regulatory authorities.

5.2.2 Training in the operational standards and procedures are required for this module and can be found in the links to the documents in Section 8 to this module. Likewise, the qualifications requirements are identified in the regulatory requirements in Section 6 which form an integral part to the implementation of this module.

6. Regulatory/standardization needs and Approval Plan (Air and Ground)

- Regulatory/standardization: use current published requirements that include the material given in Section 8.4.

- Approval plans: must be in accordance with application requirements e.g. airspace design, air traffic operations, PBN requirements for fixed radius transitions, radius-to-fix legs, required time of arrival (RTA), parallel offset, etc.

6.1 Understanding the policy context is important for making the case for local CDO implementation and ensuring high levels of participation. CDO may be a strategic objective at international, State, or local level, and as such, may trigger a review of airspace structure.

6.2 For example, noise contour production may already assume a 3-degree continuous descent final approach. Thus, even if noise performance is improved in some areas around the airport, it may not affect existing noise contours. Similarly, CDO may not affect flight performance within the area of the most significant noise contours, i.e., those depicting noise levels upon which decision-making is based.

6.3 In addition to a safety assessment, a transparent assessment of the impact of CDO on other air traffic operations and the environment should be developed and made available to all interested parties.

6.4 As PBN implementation progresses, standardized international requirements should be set for fixed radius transitions, radius-to-fix legs, required time of arrival (RTA), parallel offset, VNAV, 4D control, ADS-B, data link, etc.

6.5 SMS must be part of any development process, and each one manifests itself differently for each of the PBN processes. For production development, SMS should be addressed through an ISO 9000-compliant production process, workflow, automation improvements, and data management. The production process is monitored for defect control and workflow. For air traffic developed procedures, a safety risk management document (SRMD) may be required for every new or amended procedure. That requirement will extend the time required to implement new procedures, especially PBN-based flight procedures.

6.6 Progress should be measured against the key performance indicators recommended by the working group(s), as approved. PBN does not:

a) add new navigation philosophy, but just is a pragmatic tool to implement navigation procedures for aircraft capability that exists for more than thirty years;

b) require States to completely overhaul navigation infrastructure, but can be implemented step-by-step; and

c) require States to implement the most advanced navigation specifications, it only needs to accommodate the operational needs.

7. Implementation and Demonstration Activities (as known at time of writing)

7.1 Current use

7.1.1 Continuous descent operations

- **United States:** optimized profile descents (OPD) are currently implemented at Los Angeles International Airport (KLAX), Charlotte/Douglas International Airport (KCLT), Minneapolis-St. Paul International Airport (KMSP), Phoenix Sky Harbor International Airport (KPHX), and Las Vegas International Airport (KLAS).

7.1.2 Performance-based navigation

- **United States**: new procedures are currently being developed for Metroplexes in the United States to incorporate performance-based navigation elements such as curved paths into operations. Completion of procedure development for North Texas and Washington DC Metroplex will occur in 2013. Implementation for these two sites will occur in 2014-2015.

7.2 Planned or ongoing activities

7.2.1 Continuous descent operations:

- **United States:** New procedures are currently being developed for Denver International Airport (KDEN), Seattle/Seattle-Tacoma International Airport (KSEA), and the Chicago airspace which will incorporate OPDs. Expected completion date of 2014.

7.2.2 Performance-based navigation:

- **United States:** Trials are planned in 2014-2015 to validate the feasibility of RNP established procedures. RNP established will use RNP technology to safely direct aircraft to simultaneous independent and dependent parallel approach paths with no required vertical separation with aircraft on adjacent approaches.

8. Reference Documents

8.1 Standards

8.1.1 For flight plan requirements in Amendment 1, ICAO *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444).

8.2 Guidance material

- ICAO Doc 9613, *Performance-based Navigation (PBN) Manual*
- ICAO Doc 9931, *Continuous Descent Operations (CDO) Manual*
- FAA Advisory Circular, AC 90-105, Approval Guidance for RNP operations and barometric vertical navigation in the United States National Airspace System) which provides system and operational approval guidance for operators (only reflects the United States situation)

8.3 Approval documents

- ICAO Doc 9931, *Continuous Descent Operations Manual*
- ICAO Doc 9613, *Performance Based Navigation Manual*
- FAA AC120-108, CDFA

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Module N° B*0-CCO*: Improved Flexibility and Efficiency Departure Profiles - Continuous Climb Operations (CCO)

Summary	To implement continuous climb operations in conjunction with performance-based navigation (PBN) to provide opportunities to optimize throughput, improve flexibility, enable fuel-efficient climb profiles and increase capacity at congested terminal areas.	
Main performance impact as per Doc 9883	KPA-04 – Efficiency, KPA-05 – Environment, KPA-10 - Safety	
Operating environment/ Phases of flight	Departure and en-route	
Applicability considerations	Regions, States or individual locations most in need of these improvements. For simplicity and implementation success, complexity can be divided into three tiers: a) least complex: regional/States/locations with some foundational PBN operational experience that could capitalize on near-term enhancements, which include integrating procedures and optimizing performance; b) more complex: regional/States/locations that may or may not possess PBN experience, but would benefit from introducing new or enhanced procedures. However, many of these locations may have environmental and operational challenges that will add to the complexities of procedure development and implementation; and c) most complex: regional/States/locations in this tier will be the most challenging and complex to introduce integrated and optimized PBN operations. Traffic volume and airspace constraints are added complexities that must be confronted. Operational changes to these areas can have a profound effect on the entire State, region or location.	
Global concept component(s)s per Doc 9854	AUO – airspace user operations TS – traffic synchronization AOM – airspace organization and management	
Global plan initiatives (GPI)	GPI 5: Area navigation/required navigation performance (RNAV/RNP) (performance-based navigation) GPI-10: Terminal area design and management GPI-11: RNP and RNAV standard instrument departures (SIDS) and standard instrument arrivals (STARS)	
Main dependencies	Linkage with B*0-CCO*	
		Status (ready now or estimated date).
Global readiness checklist	Standards readiness	√
	Avionics availability	√
	Infrastructure availability	√
	Ground automation availability	√
	Procedures available	√
	Operations approvals	√

1. Narrative

1.1 General

1.1.1 This module integrates with other airspace and procedures (PBN, continuous descent operations (CDO), and airspace management) to increase efficiency, safety, access and predictability; and minimize fuel use, emissions, and noise.

1.1.2 As traffic demand increases, the challenges in terminal areas centre on volume, hazardous meteorological conditions (such as severe turbulence and low visibility), adjacent airports and special activity airspace in close proximity whose procedures utilize the same airspace, and policies that limit capacity, throughput, and efficiency.

1.1.3 Traffic flow and loading (across arrival and departure routes) are not always well metered, balanced or predictable. Obstacle and airspace avoidance (in the form of separation minima and criteria), noise abatement procedures and noise sensitive areas, as well as wake encounter risk mitigation, tend to result in operational inefficiencies (e.g. added time or distance flown, thus more fuel).

1.1.4 Inefficient routing can also cause under-use of available airfield and airspace capacity. Finally, challenges are presented to States by serving multiple customers (international and domestic with various capabilities): the intermingling of commercial, business, general aviation and many times military traffic destined to airports within a terminal area that interact and at times inhibit each other’s operations.

1.2 Baseline

1.2.1 Flight operations in many terminal areas precipitate the majority of current airspace delays in many States. Opportunities to optimize throughput, improve flexibility, enable fuel-efficient climb and descent profiles, and increase capacity at the most congested areas should be a high-priority initiative in the near-term.

1.2.2 The baseline for this module may vary from one State, region or location to the next. Noted is the fact that some aspects of the movement to PBN have already been the subject of local improvements in many areas; these areas and users are already realizing benefits.

1.2.3 The lack of ICAO PBN operational approval guidance material and subsequently the emergence of States or regional approval material, which may differ or be even more demanding than intended, is slowing down implementation and is perceived as one of the main roadblocks for harmonization.

1.2.4 There is still some work to be done to harmonize PBN nomenclature, especially in charts and States/regional regulations (e.g. most of European regulations still make use of basic area navigation (B-RNAV) and precision area navigation (P-RNAV).

1.2.5 Efficiency of climb profiles may be compromised by level off segments, vectoring, and an additional overload of radio transmissions between pilots and air traffic controllers. Existing procedure design techniques do not cater for current FMS capability to manage the most efficient climb profiles. There is also excessive use of radio transmissions due to the need to vector aircraft in an attempt to accommodate their preferred trajectories.

1.3 Change brought by the module

1.3.1 The core capabilities that should be leveraged are RNAV; RNP where possible and needed; continuous climb operations (CCO), increased efficiencies in terminal separation rules; effective airspace design and classification; and air traffic flow. Opportunities to reduce flight block times, fuel/emissions and aircraft noise impacts should also be leveraged where possible.

1.3.2 This module is a first step towards harmonization and a more optimized organization and management of the airspace. Many States will require knowledgeable assistance to achieve implementation. Initial implementation of PBN, RNAV for example, takes advantage of existing ground technology and avionics and allows extended collaboration of air navigation service providers (ANSPs) with partners: military, airspace users, and neighbouring States. Taking small and required steps and only performing what is needed or required allows States to rapidly exploit PBN.

1.4 Other remarks

1.4.1 Operating at the optimum flight level is a key driver to improve flight fuel efficiency and minimizing atmospheric emissions. A large proportion of fuel burn occurs in the climb phase and for a given route length, taking into account aircraft mass and the meteorological conditions for the flight, there will be an optimum flight level, which gradually increases as the fuel on-board is used up and aircraft mass therefore reduces. Enabling the aircraft to reach and maintain its optimum flight level without interruption will therefore help to optimize flight fuel efficiency and reduce emissions.

1.4.2 CCO can provide for a reduction in noise, fuel burn and emissions, while increasing flight stability and the predictability of flight path to both controllers and pilots.

1.4.3 CCO is an aircraft operating technique aided by appropriate airspace and procedure design and appropriate air traffic control (ATC) clearances enabling the execution of a flight profile optimized to the operating capability of the aircraft, thereby reducing fuel burn and emissions during the climb portion of flight.

1.4.4 The optimum vertical profile takes the form of a continuously climbing path, with a minimum of level flight segments only as needed to accelerate and configure the aircraft.

1.4.5 The optimum vertical path angle will vary depending on the type of aircraft, its actual weight, the wind, air temperature, atmospheric pressure, icing conditions and other dynamic considerations.

1.4.6 A CCO can be flown with or without the support of a computer-generated vertical flight path (i.e. the vertical navigation (VNAV) function of the flight management system (FMS)) and with or without a fixed lateral path. The maximum benefit for an individual flight is achieved by allowing the aircraft to climb on the most efficient climb profile along the shortest total flight distance possible.

2. Intended Performance Operational Improvement

Efficiency	Cost savings through reduced fuel burn and efficient aircraft operating profiles. Reduction in the number of required radio transmissions.
Environment	Authorization of operations where noise limitations would otherwise result in

	operations being curtailed or restricted. Environmental benefits through reduced emissions.
Safety	More consistent flight paths. Reduction in the number of required radio transmissions. Lower pilot and air traffic control workload.
Cost Benefit Analysis	It is important to consider that CCO benefits are heavily dependent on each specific ATM environment. Nevertheless, if implemented within the ICAO CCO manual framework, it is envisaged that the benefit/cost ratio (BCR) will be positive.

3. Necessary Procedures (Air and Ground)

3.1 The ICAO *Performance-based Navigation (PBN) Manual* (Doc 9613) provides general guidance on PBN implementation.

3.2 This manual identifies the relationship between RNAV and RNP applications and the advantages and limitations of choosing one or the other as the navigation requirement for an airspace concept.

3.3 It also aims at providing practical guidance to States, ANSPs and airspace users on how to implement RNAV and RNP applications, and how to ensure that the performance requirements are appropriate for the planned application.

3.4 The ICAO *Continuous Climb Operations (CCO) Manual* (Doc xxxx – under development) provides guidance on the airspace design, instrument flight procedures, ATC facilitation and flight techniques necessary to enable continuous descent profiles.

3.5 It therefore provides background and implementation guidance for:

a) air navigation service providers;

b) aircraft operators;

c) airport operators; and

d) aviation regulators.

4. Necessary System Capability

4.1 Avionics

4.1.1 CCO does not require a specific air or ground technology. It is an aircraft operating technique aided by appropriate airspace and procedure design, and appropriate ATC clearances enabling the execution of a flight profile optimized to the operating capability of the aircraft, in which the aircraft can attain cruise altitude flying at optimum air speed with climb engine thrust settings set throughout the climb, thereby reducing total fuel burn and emissions during the whole flight. Reaching cruise flight levels sooner where higher ground speeds are attained can also reduce total flight block times. This may allow a reduced initial fuel upload with further fuel, noise and emissions reduction benefits.

4.1.2 The optimum vertical profile takes the form of a continuously climbing path. Any level or non-optimal reduced climb rate segments during the climb to meet aircraft separation requirements should be avoided. Achieving this whilst also enabling CDO is critically dependent upon the airspace design and the height windows applied in the instrument flight procedure. Such designs need an understanding of the optimum profiles for aircraft operating at the airport to ensure that the height windows avoid, to greatest extent possible, the need to resolve potential conflicts between the arriving and departing traffic flows through ATC height or speed constraints.

4.2 Ground systems

4.2.1 Controllers would benefit from some automation support to display aircraft capabilities in order to know which aircraft can do what.

5. Human Performance

5.1 Human factors considerations

5.1.1 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 (see Section 6 for examples). The possibility of latent failures 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

5.3 Training in the operational standards and procedures are required for this module and can be found in the links to the documents in Section 8 to this module. Likewise, the qualifications requirements are identified in the regulatory requirements in Section 6 which form an integral part to the implementation of this module**.**

6. Regulatory/standardization needs and Approval Plan (Air and Ground)

- Regulatory/standardization: use current published requirements that include the material given in Section 8.4.

- Approval plans: must be in accordance with application requirements.

6.1 Understanding the policy context is important for making the case for local CCO implementation and ensuring high levels of participation. CCO may be a strategic objective at international, State, or local level, and as such, may trigger a review of airspace structure when combined with CDO.

6.2 For example, noise contour production may be based on a specific departure procedure (noise abatement departure procedure 1 (NADP1) or NADP2-type). Noise performance can be improved in some areas around the airport, but it may affect existing noise contours elsewhere. Similarly CCO can enable several specific strategic objectives to be met and should therefore be considered for inclusion within any airspace concept or redesign. Guidance on airspace concepts and strategic objectives is contained in the *Performance-based Navigation (PBN) Manual* (Doc 9613). Objectives are usually collaboratively identified by airspace users, ANSPs, airport operators as well as by government policy. Where a change could have an impact on the environment, the development of an airspace concept may involve local communities, planning authorities and local government, and may require formal impact assessment under regulations. Such involvement may also be the case in the setting of the strategic objectives for airspace. It is the function of the airspace concept and the concept of operations to respond to these requirements in a balanced, forward-looking manner, addressing the needs of all stakeholders and not of one of the stakeholders only (e.g. the environment). Doc 9613, Part B, Implementation Guidance, details the need for effective collaboration among these entities.

6.3 In the case of a CCO, the choice of a departure procedure (NADP1 or NADP2-type), requires a decision of the dispersion of the noise. In addition to a safety assessment, a transparent assessment of the impact of CCO on other air traffic operations and the environment should be developed and made available to all interested parties.

7. Implementation and Demonstration Activities (as known at time of writing)

7.1 Current use

- **United States:** procedures are currently being developed to incorporate optimized climb profiles as part of procedure and airspace development.

7.2 Planned or ongoing activities

- **United States:** none at this time.

8. Reference Documents

8.1 Procedures

- *ICAO Doc 8168, Procedures for Air Navigation Services — Aircraft Operations*
- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management Guidance Material*
- ICAO Doc 9613, *Performance-based Navigation (PBN) Manual*
- ICAO Doc xxxx, *Continuous Climb Operations (CCO) Manual* (under development)

8.2 **Approval documents**

- ICAO Doc xxxx, *Continuous Climb Operations (CCO)Manual* (under development)
- ICAO Doc 9613, *Performance Based Navigation Manual*
- ICAO Doc 4444, *Procedures for Air Navigation Services — Air Traffic Management*

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APPENDIX B

MID Region Air Navigation Strategy

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MID Region Air Navigation Strategy

Strategic Air Navigation Capacity and Efficiency Objective:

To realize sound and economically-viable civil aviation system in the MID Region that continuously increases in capacity and improves in efficiency with enhanced safety, security and facilitation while minimizing the adverse environmental effects of civil aviation activities.

Background

The Global ATM Operational Concept was approved by the Eleventh Air Navigation Conference (Montreal, September-October 2003) and published as Doc. 9854-AN/458.

In order to align global planning to the ATM Operational Concept, the Eleventh Air Navigation Conference (AN-Conf/11), recommended States and Regional Planning and Implementation Groups (PIRG), through Recommendation 1/1, to consider the Concept as a common global framework to guide in the planning for the implementation of the systems in support of the air navigation services.

The 37 Session of the International Civil Aviation Organization (ICAO) General Assembly (2010) directed the Organization to double its efforts to meet the global needs for airspace interoperability while maintaining its focus on safety. The Aviation System Block Upgrades (ASBU) methodology was formalized at the Twelfth Air Navigation Conference (AN-Conf/12) (Montreal, November 2012) and is part of the new GANP, 4th Edition (Doc 9750) available at http://www.icao.int/Meetings/a38/Documents/GANP_en.pdf

The block upgrades describe a way to apply the concepts defined in the GANP with the goal of implementing regional performance improvements. They include the development of technology roadmaps, to ensure that standards are mature and to facilitate synchronized implementation between air and ground systems and between regions. The ultimate goal is to achieve global interoperability. Safety demands this level of interoperability and harmonization but it must be achieved at a reasonable cost with commensurate benefits.

Through Recommendation 6/1 - *Regional performance framework – planning methodologies and tools*, AN-Conf/12 urged States and PIRGs to harmonize the regional and national air navigation plans with the ASBU methodology in response to this, the MID region is developing MID Region Air Navigation Strategy that is aligned with the ASBU methodology.

Stakeholder roles and responsibilities

Stakeholders including service providers, regulators, airspace users and manufacturers are facing increased levels of interaction as new, modernized ATM operations are implemented. The highly integrated nature of capabilities covered by the block upgrades requires a significant level of coordination and cooperation among all stakeholders. Working together is essential for achieving global harmonization and interoperability.

With the ASBU methodology States, operators and industry will benefit from the availability of Standards and Recommended Practices (SARPs) with realistic lead times. This will enable regional regulations to be identified, allowing for the development of adequate action plans and, if needed, investment in new facilities and/or infrastructure.

For the industry, this constitutes a basis for planning future development and delivering products on the market at the proper target time. For service providers or operators, ASBU should serve as a planning tool for resource management, capital investment, training as well as potential reorganization.

Introduction

As traffic volume increases throughout the world, the demands on air navigation service providers in a given airspace increase, and air traffic management becomes more complex. Increased traffic density brings about an increase in the number of flights that cannot fly their optimum path.

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It is foreseen that the implementation of the components of the ATM operational concept will provide sufficient capacity to meet the growing demand, generating additional benefits in terms of more efficient flights and higher levels of safety. Nevertheless, the potential of new technologies to significantly reduce the cost of services will require the establishment of clear operational requirements.

Taking into account the benefits of the ATM operational concept, it is necessary to make many timely decisions for its implementation. An unprecedented cooperation and harmonization will be required at both global and regional level.

ICAO introduced the Aviation System Block Upgrades (ASBU) methodology as a systemic manner to achieve a harmonized implementation of the air navigation services.

With the introduction of the ASBU the Performance Framework Forms (PFF) are restructured and aligned with the ASBU modules, and renamed as Air Navigation Report Forms (ANRF) and presents a standard format for high level monitoring of the ASBU module implementation, where as detailed monitoring of the implementation will be developed in Volume III of the revised new Regional Air Navigation Plans.

Aviation System Block Upgrades (ASBU) framework

An ASBU designates a set of improvements that can be implemented globally from a defined point in time to enhance the performance of the ATM system. There are four components of a block upgrade.

Module – is a deployable package (performance) or capability. A module will offer an understandable performance benefit, related to a change in operations, supported by procedures, technology, regulations/standards as necessary, and a business case. A module will be also characterized by the operating environment within which it may be applied. The date allocated to a module in a block is that of the initial operating capability (IOC).

Of some importance is the need for each of the modules to be both flexible and scalable to the point where their application could be managed through any set of regional plans and still realize the intended benefits. The preferential basis for the development of the modules relied on the applications being adjustable to fit many regional needs as an alternative to being made mandated as a one-size-fits-all application. Even so, it is clear that many of the modules developed in the block upgrades will not be necessary to manage the complexity of air traffic management in many parts of the world.

Thread – describes the evolution of a given capability through the successive block upgrades, from basic to more advanced capability and associated performance, while representing key aspects of the global ATM concept

Block – is made up of modules that when combined enable significant improvements and provide access to benefits.

The notion of blocks introduces a form of date segmentation in five year intervals. However, detailed considerations will call for more accurate implementation dates, often not at the exact assigned block date. The purpose is not to indicate when a module implementation must be completed unless dependencies among modules logically suggest such a completion date.

Performance improvement area (PIA) – sets of modules in each block are grouped to provide operational and performance objectives in relation to the environment to which they apply, thus forming an executive view of the intended evolution. The PIAs facilitate comparison of on-going programmes.

The four PIAs are as follows:

a) airport operations;
b) globally interoperable systems and data – through globally interoperable system-wide information management;
c) optimum capacity and flexible flights – through global collaborative ATM; and
d) efficient flight paths – through trajectory-based operations.

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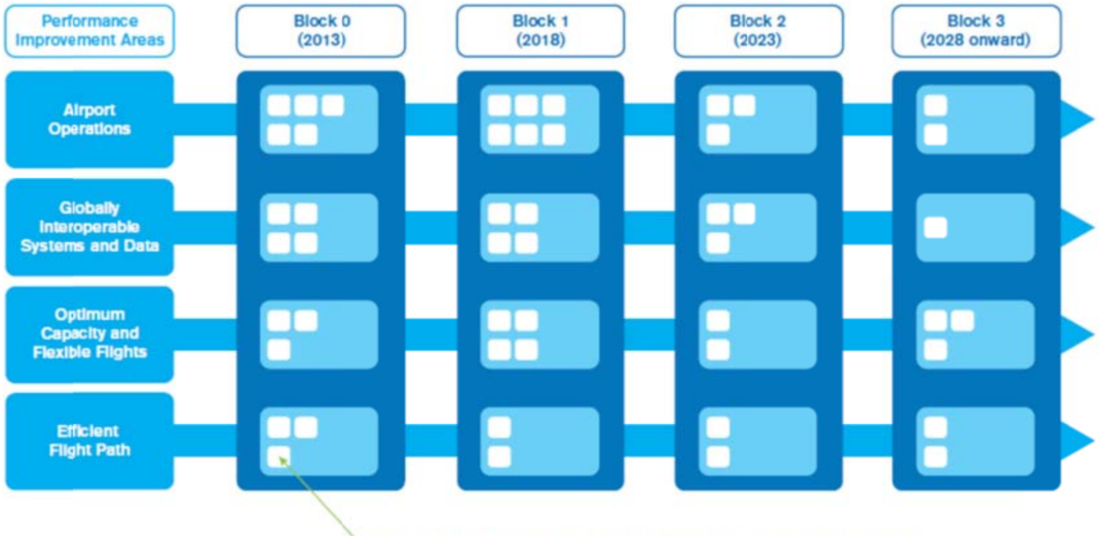
Figure 1 illustrates the relationships between the modules, threads, blocks, and PIAs.



Modules (actual number of modules per Block/Performance Area may vary)

Figure 1.

MID Air Navigation Objectives:

States must focus on their Air Navigation Capacity and Efficiency priorities as they continue to foster expansion of the air transport sectors.

The ICAO Global Air Navigation Plan (GANP) represents a rolling strategic methodology which leverages existing technologies and anticipates future developments based on State/industry agreed operational objectives. The Block Upgrades are organized in five-year time increments starting in 2013 and continuing through 2028 and beyond. This structured approach provides a basis for sound investment strategies and will generate commitment from States, equipment manufacturers, operators and service providers.

The Global Plan offers a long-term vision that will assist ICAO, States and industry to ensure continuity and harmonization among their modernization programmes. It also explores the need for more integrated aviation planning at both the regional and State level and addresses required solutions by introducing Aviation System Block Upgrade (ASBU) methodology.

The MID Region air navigation objectives are in line with the global air navigation objectives and address specific air navigation operational improvements identified within the framework of the Middle East Regional Planning and Implementation Group (MIDANPIRG).

The enhancement of communication and information exchange between aviation Stakeholders and their active collaboration under the framework of MIDANPIRG would help achieving the MID Region Air Navigation objectives in an expeditious manner.

Near-term Objective (2013 - 2018): ASBU Block 0

The Fourth Edition of the *Global Air Navigation Plan* introduces ICAO's ASBU methodology and supporting technology roadmaps based on a rolling fifteen-year planning horizon. Although the GANP has a global perspective, it is not intended that all ASBU modules are to be applied around the globe. Some of the ASBU modules contained in the GANP are specialized packages that should be applied where specific operational requirements or corresponding benefits exist.

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Although some modules are suitable for entirely stand-alone deployment, an overall integrated deployment of a number of modules could generate additional benefits. The benefits from an integrated implementation of a number of modules may be greater than the benefits from a series of isolated implementations. Similarly, the benefits from the coordinated deployment of one module simultaneously across a wide area (e.g. a number of proximate airports or a number of contiguous airspaces/flight information regions) may exceed the benefits of the implementations conducted on an ad hoc or isolated basis.

An example of a need for global applicability would be performance-based navigation (PBN). Assembly Resolution A37-11 urges all States to implement approach procedures with vertical guidance in accordance with the PBN concept. Therefore, the ASBU modules on PBN approaches should be seen as required for implementation at all airports. In the same way, some modules are well suited for regional or sub-regional deployment and should take this into account when considering which modules to implement regionally and in what circumstances and agreed timeframes.

Block ‘0’ features Modules characterized by operational improvements which have already been developed and implemented in many parts of the world today. It therefore has a near-term implementation period of 2013–2018, whereby 2013 refers to the availability of its particular performance Modules and 2018 the target implementation deadline. It is not the case that all States will need to implement every Module, and ICAO will be working with its Members to help each determine exactly which capabilities they should have in place based on their unique operational requirements.

It is important to clarify how each ASBU module fits into the framework of the MID Regional Air Navigation system. On the basis of operational requirements and taking into consideration benefits associated, MID Region has chosen 8 out of 18 Block “0” Module for implementation as they respond to air navigation capacity and efficiency requirements for the Region for the period from 2013 to 2018.

Table 1

Performance Improvement Areas (PIA)	Performance Improvement Area Name	Module	Module Name
PIA 1	Airport Operations	B0-65 APTA	Optimization of Approach Procedures including vertical guidance
		B0-75 SURF	Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2)
PIA 2	Globally Interoperable Systems and Data - Through Globally Interoperable System Wide Information Management	B0-25 FICE	Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration
		B0-30 DAIM	Service Improvement through Digital Aeronautical Information Management
		B0-105 AMET	Meteorological information supporting enhanced operational efficiency and safety
PIA 3	Optimum Capacity and Flexible Flights – Through Global Collaborative ATM	B0-10 FRTO	Improved Operations through Enhanced En-Route Trajectories
PIA 4	Efficient Flight Path – Through Trajectory-based Operations	B0-05 CDO	Improved Flexibility and Efficiency in Descent Profiles (CDO)
		B0-20 CCO	Improved Flexibility and Efficiency Departure Profiles - Continuous Climb Operations (CCO)

Mid-term Objective (2018 - 2023): ASBU Block 1

Block 0 features Modules characterized by technologies and capabilities which have already been developed and implemented in many parts of the world today. It therefore features a near-term availability milestone, or Initial Operating Capability (IOC), of 2013 based on regional and State operational need. Blocks 1 through 3 are characterized by both existing and projected performance area solutions, with availability milestones beginning in 2018, 2023 and 2028 respectively.

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Associated timescales are intended to depict the initial deployment targets along with the readiness of all components needed for deployment. It must be stressed that a Block's availability milestone is not the same as a deadline.

Long-term Objective (2023 - 2028): ASBU Block 2

The Block Upgrades incorporate a long-term perspective matching that of the three companion ICAO Air Navigation planning documents. They coordinate clear aircraft- and ground-based operational objectives together with the avionics, data link and ATM system requirements needed to achieve them. The overall strategy serves to provide industry wide transparency and essential investment certainty for operators, equipment manufacturers and ANSPs.

Measuring and monitoring air navigation Performance:

The monitoring of air navigation performance and its enhancement is achieved through identification of relevant air navigation Metrics and Indicators as well as the adoption and attainment of air navigation system Targets.

The MID Region Air Navigation Performance Framework is based on the implementation of the Block 0 Modules shown in **Table 1** as a priority.

The MID Region air navigation Key Performance Indicators, Targets and Action Plans are detailed in the **Table 2** below.

Attachment A presents the Air Navigation Report Forms for each of the eight ASBU Block 0 Module endorsed in the MID Region, as a priority.

Note*: The different elements supporting the implementation are explained in the ASBU Document, and Global Plan (Doc 9750)*

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MONITORING OF THE AVIATION SYSTEM BLOCK UPGRADES (ASBUS)

IMPLEMENTATION IN THE MID REGION

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B0 – APTA: Optimization of Approach Procedures including vertical guidance

Description and purpose

The use of performance-based navigation (PBN) and ground-based augmentation system (GBAS) landing system (GLS 1) procedures will enhance the reliability and predictability of approaches to runways, thus increasing safety, accessibility and efficiency. This is possible through the application of Basic global navigation satellite system (GNSS), Baro vertical navigation (VNAV), satellite-based augmentation system (SBAS) and GLS. The flexibility inherent in PBN approach design can be exploited to increase runway capacity.

Main performance impact:

KPA- 01 – Access and Equity	KPA-02 – Capacity	KPA-04 – Efficiency	KPA-05 – Environment	KPA-10 – Safety
Y	Y	Y	Y	Y

Applicability consideration:

This module is applicable to all instrument, and precision instrument runway ends, and to a limited extent, non-instrument runway ends.

Implementation Roadblocks/Issues/Challenges

- Insufficient number of equipped aircraft
- Lack of cost benefit analysis adverse ionosphere
- Lack of appropriate training
- Evaluation of a real operational requirement

B0 – APTA: Optimization of Approach Procedures including vertical guidance

Applicability: *Aerodromes/RWYs (TBD)*

Elements	***Performance Indicators/Supporting Metrics***	***Targets***	***Action Plan***	***Remarks***
LNAV approaches	Indicator: % of runway ends with LNAV	All instrument runway ends, either as the primary approach or as a back-up		

	approach Supporting metric: Number of Instrument Runways ENDs provided with GNSS Approach Procedures (LNAV)	for precision approaches by 2016		
LNAV/VNAV approaches	Indicator: % of instrument Runways ENDs provided with APV Approach procedures (VNAV) Supporting metric: Number of instrument Runways ENDs provided with APV Approach procedures (VNAV)			
APV with GBAS	Indicator: % of runway ends with APV GBAS Supporting metric Number Percentage of runway ends with APV GBAS			

Module N° B0-SURF: Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2)

Description and purpose

Basic A-SMGCS provides surveillance and alerting of movements of both aircraft and vehicles on the aerodrome thus improving runway/aerodrome safety. ADS-B information is used when available (ADS-B APT).

Main performance impact:

KPA- 01 – Access and Equity	KPA-02 – Capacity	KPA-04 – Efficiency	KPA-05 – Environment	KPA-10 – Safety
Y	Y	Y	Y	Y

Applicability consideration:

A-SMGCS is applicable to any aerodrome and all classes of aircraft/vehicles. Implementation is to be based on requirements stemming from individual aerodrome operational and cost-benefit assessments. ADS B APT, when applied is an element of A-SMGCS, is designed to be applied at aerodromes with medium traffic complexity, having up to two active runways at a time and the runway width of minimum 45 m.

Implementation Roadblocks/Issues/Challenges

- Lack of procedures and training
- Lack of inspector for approvals operations
- Lack of surveillance system on board (ADS B capacity)

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Applicability: Aerodromes (TBD) ,

Elements	**Performance Indicators/Supporting Metrics**	**Targets**	**Action Plan**	***Remarks***
Surveillance system for ground surface movement (PSR, SSR, ADS B or Multilateration)	Indicator: % of international aerodromes with SMR/ SSR Mode S/ ADS-B Multilateration for ground surface movement Supporting Metric: Number of international aerodromes with SMR/ SSR Mode S/ ADS-B Multilateration for ground surface movement		1- Study requirement and cost benefits assessments Responsible: Aerodrome operator+ CNS/ATM directorate 2-establish Surveillance system for ground surface movement (PSR, SSR, ADS B or Multilateration) 3- Develop procedures and conduct training	
Surveillance system on board (SSR transponder, ADS B capacity)				
Surveillance system for vehicles			Study requirement and cost benefits assessments Establish Surveillance system for vehicle Develop procedures and conduct training	
Visual aids for navigation	Indicator: **%** of international aerodromes complying with visual aid requirements as per Annex 14 Supporting metric: Number of international aerodromes complying with visual aid requirements as per Annex 14			

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B0 – FICE: Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration

Description and purpose

To improve coordination between air traffic service units (ATSUs) by using ATS interfacility data communication (AIDC) defined by the ICAO *Manual of Air Traffic Services Data Link Applications* (Doc 9694). The transfer of communication in a data link environment improves the efficiency of this process particularly for oceanic ATSUs.

Main performance impact:

KPA- 01 – Access and Equity	KPA-02 – Capacity	KPA-04 – Efficiency	KPA-05 – Environment	KPA-10 – Safety
N	Y	Y	N	Y

Applicability consideration:

Applicable to at least two area control centres (ACCs) dealing with enroute and/or terminal control area (TMA) airspace. A greater number of consecutive participating ACCs will increase the benefits.

Implementation Roadblocks/Issues/Challenges

- TPDI negotiations between MTAs and
- Compatibility between AIDC or OLDI systems from various manufacturers.

<table>
<tr><td colspan="5"><i>B0 – FICE: Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration</i></td></tr>
<tr><td colspan="5"><i>Applicability:</i> <i>States/ACCs (TBD)</i></td></tr>
<tr><th><i>Elements</i></th><th><i>Performance Indicators/Supporting Metrics</i></th><th><i>Targets</i></th><th><i>Action Plan</i></th><th><i>Remarks</i></th></tr>
<tr><td>AMHS implementation</td><td>Indicator: Percentage of States with AMHS implemented
Supporting metric: Number of AMHS installed</td><td></td><td>1- Complete AMHS implementation for all States of the region</td><td></td></tr>
<tr><td>AMHS interconnection</td><td>Indicator: Percentage of States with AMHS interconnected with other AMHS
Supporting metric: Number of AMHS interconnections implemented</td><td></td><td>Complete AMHS interconnection</td><td></td></tr>
<tr><td>Implement operational AIDC/OLDI between adjacent ACCs</td><td>Indicator: Percentage of ACCs with AIDC or OLDI systems interconnection implemented
Supporting metric: Number of AIDC or OLDI interconnections implemented, as per Plan</td><td></td><td>Implement operational AIDC/OLDI between adjacent ACC´s and complete the LOA</td><td></td></tr>
</table>

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B0 – DAIM: Service Improvement through Digital Aeronautical Information Management

Description and purpose

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:

KPA- 01 – Access and Equity	KPA-02 – Capacity	KPA-04 – Efficiency	KPA-05 – Environment	KPA-10 – Safety
N	N	Y	Y	Y

Applicability consideration:

Applicable at State level, with increased benefits as more States participate

Implementation Roadblocks/Issues/Challenges

- Lack of electronic Database.
- Lack of electronic access based on Internet protocol services.
- Lack of procedures to allow airlines provide digital AIS data to on-board devices, in particular electronic flight bags (EFBs).
- Lack of training for AIS/AIM personnel

B0 – DAIM: Service Improvement through Digital Aeronautical Information Management

Applicability: *All States*

Elements	***Performance Indicators/Supporting Metrics***	***Targets***	***Action Plan***	***Remarks***
1-AIXM	Indicator: % of States that have implemented an AIXM-based Integrated Aeronautical Information Database (IAID) Supporting Metric: Number of States that have implemented an AIXM-based Integrated Aeronautical Information Database (IAID)			
2-eAIP	Indicator: % of States that have implemented an IAID driven AIP Production (eAIP) Supporting Metric: Number of States that have implemented an IAID driven AIP Production (eAIP)			

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3-QMS	Indicator: % of States that have implemented QMS for AIS/AIM Supporting Metric: Number of States that have implemented QMS for AIS/AIM			
4-WGS-84	Indicator: % of States that have implemented WGS-84 for Enroute Supporting Metric: Number of States that have implemented WGS-84 for Enroute Indicator: % of States that have implemented WGS-84 for Terminal Supporting Metric: Number of States that have implemented WGS-84 for Terminal Indicator: % of States that have implemented WGS-84 for Aerodromes Supporting Metric: Number of States that have implemented WGS-84 for Aerodromes Indicator: % of States that have implemented Geoid Undulation Supporting Metric: Number of States that have implemented Geoid Undulation			
5-eTOD	Indicator: % of States that have implemented required Terrain datasets Supporting Metric: Number of States that have implemented required Terrain datasets Indicator: % of States that have implemented required Obstacle datasets Supporting Metric: Number of States that have implemented required Obstacle datasets			

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6-Digital NOTAM*	Plan for the implementation of Digital NOTAM			

B0 – AMET: Meteorological information supporting enhanced operational efficiency and safety

Description and purpose

Global, regional and local meteorological information:

a) forecasts provided by world area forecast centres (WAFC), volcanic ash advisory centres (VAAC) and tropical cyclone advisory centres (TCAC);

b) aerodrome warnings to give concise information of meteorological conditions that could adversely affect all aircraft at an aerodrome including wind shear; and

c) SIGMETs to provide information on occurrence or expected occurrence of specific en-route weather phenomena which may affect the safety of aircraft operations and other operational meteorological (OPMET) information, including METAR/SPECI and TAF, to provide routine and special observations and forecasts of meteorological conditions occurring or expected to occur at the aerodrome.

This module includes elements which should be viewed as a subset of all available meteorological information that can be used to support enhanced operational efficiency and safety.

Main performance impact:

KPA- 01 – Access and Equity	KPA-02 – Capacity	KPA-04 – Efficiency	KPA-05 – Environment	KPA-10 – Safety
N	Y	Y	Y	Y

Applicability consideration:

Applicable to traffic flow planning, and to all aircraft operations in all domains and flight phases, regardless of level of aircraft equipage.

Implementation Roadblocks/Issues/Challenges

B0 – AMET: Meteorological information supporting enhanced operational efficiency and safety				
***Applicability: All** States*				
Elements	***Performance Indicators/Supporting Metrics***	***Targets***	***Action Plan***	***Remarks***
SADIS 2G satellite broadcast	Indicator: % of States implemented SADIS 2G satellite broadcast Supporting metric: : % of States implemented SADIS 2G satellite broadcast			
Secure SADIS ETP service	Indicator: % of States implemented Secure SADIS ETP service			

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	Supporting metric: : % of States implemented Secure SADIS ETP service			
WAFS				
IAVW				
Tropical cyclone watch				
Aerodrome warnings				
Wind shear warnings and alerts				
SIGMET and other operational meteorological (OPMET) information				

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B0 – FRTO: Improved Operations through Enhanced En-Route Trajectories

Description and purpose

To allow the use of airspace which would otherwise be segregated (i.e. special use airspace) along with flexible routing adjusted for specific traffic patterns. This will allow greater routing possibilities, reducing potential congestion on trunk routes and busy crossing points, resulting in reduced flight length and fuel burn.

Main performance impact:

KPA- 01 – Access and Equity	KPA-02 – Capacity	KPA-04 – Efficiency	KPA-05 – Environment	KPA-10 – Safety
Y	Y	Y	Y	N/A

Applicability consideration:

Applicable to en-route and terminal airspace. Benefits can start locally. The larger the size of the concerned airspace the greater the benefits, in particular for flex track aspects. Benefits accrue to individual flights and flows. Application will naturally span over a long period as traffic develops. Its features can be introduced starting with the simplest ones.

Implementation Roadblocks/Issues/Challenges

- Lack of organize and manage airspace prior to the time of flight
- Lack of AIDC
- Poor percentage of fleet approvals

- Lack of procedures
- Lack of implementation FUA Guidance
- Lack of LOAs

B0 – FRTO: Improved Operations through Enhanced En-Route Trajectories				
Applicability: *States*				
Elements	***Performance Indicators/Supporting Metrics***	***Targets***	***Action Plan***	***Remarks***
Flexible use of airspace (FUA)	Percentage of Airspace under Full Control of Civil Authority Percentage of Airspace under Full Control of Military Authority (Dangerous, Prohibited, Restricted Areas etc…) Percentage of Airspace Jointly used by Civil and Military Authorities			
Flexible routing	Indicator: % of established Routes overflying segregated airspace Supporting metric: Number of established Routes overflying segregated airspace			

B0 – CDO: Improved Flexibility and Efficiency in Descent Profiles (CDO)

Description and purpose

To use performance-based airspace and arrival procedures allowing aircraft to fly their optimum profile using continuous descent operations (CDOs). This will optimize throughput, allow fuel efficient descent profiles and increase capacity in terminal areas.

Main performance impact:

KPA- 01 – Access and Equity	KPA-02 – Capacity	KPA-04 – Efficiency	KPA-05 – Environment	KPA-10 – Safety
N	Y	Y	Y	Y

KPA- 01 – Access and Equity, KPA-02 – Capacity, KPA-04 – Efficiency, KPA-05 – Environment, KPA-10 – Safety.

Applicability consideration:

Regions, States or individual locations most in need of these improvements. For simplicity and implementation success, complexity can be divided into three tiers:

a) least complex – regional/States/locations with some foundational PBN operational experience that could capitalize on near term enhancements, which include integrating procedures and optimizing performance;

b) more complex – regional/States/locations that may or may not possess PBN experience, but would benefit from introducing new or enhanced procedures. However, many of these locations may have environmental and operational challenges that will add to the complexities of procedure development and implementation; and

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c) most complex – regional/States/locations in this tier will be the most challenging and complex to introduce integrated and optimized PBN operations. Traffic volume and airspace constraints are added complexities that must be confronted. Operational changes to these areas can have a profound effect on the entire State, region or location

Implementation Roadblocks/Issues/Challenges

- Airspace Design
- LOAs and Training

B0 – CDO: Improved Flexibility and Efficiency in Descent Profiles (CDO)				
Applicability: *Aerodromes*				
Elements	***Performance Indicators/Supporting Metrics)***	***Targets***	***Action Plan***	***Remarks***
International aerodromes/TMAs with CDO	Indicator: % of International Aerodromes/TMA with CDO implemented Supporting Metric: Number of International Aerodromes/TMAs with CDO implemented		Upgrade the ground trajectory calculation function Airspace Design LOAs and Training Define application requirements	
PBN STARs	Indicator: % of International Aerodromes/TMA with PBN STAR implemented Supporting Metric: Number of International Aerodromes/TMAs with PBN STAR implemented			

B0 – CCO: Improved Flexibility and Efficiency Departure Profiles - Continuous Climb Operations (CCO)

Description and purpose

To implement continuous climb operations in conjunction with performance-based navigation (PBN) to provide opportunities to optimize throughput, improve flexibility, enable fuel-efficient climb profiles and increase capacity at congested terminal areas.

Main performance impact:

KPA- 01 – Access and Equity	KPA-02 – Capacity	KPA-04 – Efficiency	KPA-05 – Environment	KPA-10 – Safety
N/A	N/A	Y	Y	Y

Applicability consideration:

Regions, States or individual locations most in need of these improvements. For simplicity and implementation success, complexity can be divided into three tiers:

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a) least complex: regional/States/locations with some foundational PBN operational experience that could capitalize on near-term enhancements, which include integrating procedures and optimizing performance;
b) more complex: regional/States/locations that may or may not possess PBN experience, but would benefit from introducing new or enhanced procedures. However, many of these locations may have environmental and operational challenges that will add to the complexities of procedure development and implementation; and
c) most complex: regional/States/locations in this tier will be the most challenging and complex to introduce integrated and optimized PBN operations. Traffic volume and airspace constraints are added complexities that must be confronted. Operational changes to these areas can have a profound effect on the entire State, region or location.

Implementation Roadblocks/Issues/Challenges
- Airspace Design,
- LOAs; and
- Training

B0 – CCO: Improved Flexibility and Efficiency Departure Profiles - Continuous Climb Operations (CCO)				
Applicability: *Aerodromes*				
Elements	***Performance Indicators/Supporting Metrics***	***Targets***	***Action Plan***	***Remarks***
International aerodromes/TMAs with CCO	Indicator: % of International Aerodromes/TMA with CCO implemented Supporting Metric: Number of International Aerodromes/TMAs with CCO implemented		Airspace Design LOAs and Training Define application requirements	
PBN SIDs	Indicator: % of International Aerodromes/TMA with PBN SID implemented Supporting Metric: Number of International Aerodromes/TMAs with PBN SID implemented			

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Action Plans:

MIDANPIRG through its activities under the various subsidary bodies will continue to develop, update and monitor the implementation of Action Plans to achieve the air navigation targets.

A progress report on the implementation of the Action Plans and achieved targets will be developed by the Air Navigation System Implemenation Group (ANSIG) and presented to MIDANPIRG.

Governance:

The MIDANPIRG will be the governing body responsible for the review and update of the MID Region Air Navigation Strategy.

The MID Region Air Navigation Strategy will guide the work of MIDANPIRG and all its member States and partners.

Progress on the implementation of the MID Region Air Navigation Strategy and the achievement of the agreed air navigation Targets will be reported to the ICAO Air navigation Commission (ANC), through the review of the MIDANPIRG reports; and to the stakeholders in the Region within the framework of MIDANPIRG.

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MID Regional Planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – B0-05: Improved Flexibility and Efficiency in Descent Profiles (CDO) Performance Improvement Area 4: Efficient Flight Path – Through Trajectory-based Operations					
ASBU B0-05: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	N	Y	N	Y

ASBU B0-05: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. CDO implementation	Dec.2017
2. PBN STARs	Dec.2017

ASBU B0-05: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. CDO implementaion	The ground trajectory calculation function will need to be upgraded.	CDO Function	LOAs and Training	In accordance with application requirements
2. PBN STARs	Airspace Design		LOAs and Training	

ASBU B0-05: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. CDO implementation	Indicator: % of International Aerodromes/TMA with CDO implemented Supporting Metric: Number of International Aerodromes/TMAs with CDO implemented
2. PBN STARs	Indicator: % of International Aerodromes/TMA with PBN STAR implemented Supporting Metric: Number of International Aerodromes/TMAs with PBN STAR implemented

ASBU B0-05: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	NA
Capacity	NA
Efficiency	Cost savings through reduced fuel burn. Reduction in the number of required radio transmissions
Environment	Reduced emissions as a result of reduced fuel burn
Safety	More consistent flight paths and stabilized approach paths. Reduction in the incidence of controlled flight into terrain (CFIT

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MID Regional Planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – Module N° B0-(105)AMET: Meteorological information supporting enhanced operational efficiency and safety **Performance Improvement Area 2:** **Globally Interoperable Systems and Data – Through Globally Interoperable System Wide Information Management**					
ASBU B0-(105)AMET: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	Y	Y	Y	Y

ASBU B0-(105)AMET: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. WAFS	In process of improvement
2. IAVW	In process of improvement
3. Tropical cyclone watch	In process of improvement
4. Aerodrome warnings	In process of improvement
5. Wind shear warnings and alerts	MET provider services / 2015
6. SIGMET	MET provider services / 2015
7. QMS/MET	MET provider services / 2018

ASBU B0-105: Meteorological information supporting enhanced operational efficiency and safety				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. WAFS	Connection to the AFS satellite and public Internet distribution systems	Nil	Prepare a contingency plan in case of public Internet failure	N/A
2. IAVW	Connection to the AFS satellite and public Internet distribution systems	Nil	Prepare a contingency plan in case of public Internet failure	N/A
3. Tropical cyclone watch	Connection to the AFS satellite and public Internet distribution systems	Nil	Prepare a contingency plan in case of public Internet failure	N/A

ASBU B0-105: Meteorological information supporting enhanced operational efficiency and safety				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
4. Aerodrome warnings	Connection to the AFTN	Nil	Local arrangements for reception of aerodrome warnings	N/A
5. Wind shear warnings and alerts	Connection to the AFTN	Nil	Local arrangements for reception of wind shear warning and alerts	N/A
6. SIGMET	Connection to the AFTN	Nil	N/A	N/A
7. QMS/MET	Nil	Commitment of top management	N/A	N/A

ASBU B0-105: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. WAFS	Indicator: States implementation of WAFS Internet File Service (WIFS) Supporting metric: Number of States implementation of WAFS Internet File Service (WIFS)
2. IAVW	Indicator: Percentage of international aerodromes/MWOs with IAVW procedures implemented Supporting metric: Number of international aerodromes/MWOs with IAVW procedures implemented
3. Tropical cyclone watch	Indicator: Percentage of international aerodromes/MWOs with tropical cyclone watch procedures implemented Supporting metric: Number of international aerodromes/MWOs with tropical cyclone watch
4. Aerodrome warnings	Indicator: Percentage of international aerodromes/AMOs with Aerodrome warnings implemented Supporting metric: Number of international aerodromes/AMOs with Aerodrome warnings implemented
5. Wind shear warnings and alerts	Indicator: Percentage of international aerodromes/AMOs with wind shear warnings procedures implemented Supporting metric: Number of international aerodromes/AMOs with wind shear warnings and alerts implemented
6. SIGMET	Indicator: Percentage of international aerodromes/MWOs with SIGMET procedures implemented Supporting metric: Number of international aerodromes/MWOs with SIGMET procedures implemented
7. QMS/MET	Indicator: Percentage of MET Provider Sates with QMS/MET implemented Supporting metric: Number of MET Provider Sates with QMS/MET certificated

ASBU B0-105: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	Not applicable
Capacity	Optimized usage of airspace and aerodrome capacity due to MET support
Efficiency	Reduced arrival/departure holding time, thus reduced fuel burn due to MET support
Environment	Reduced emissions due to reduced fuel burn due to MET support
Safety	Reduced incidents/accidents in flight and at international aerodromes due to MET support.

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MID Regional Planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – ASBU B0-10: Improved Operations through Enhanced En-Route Trajectories **Performance Improvement Area3: Optimum Capacity and Flexible Flights – Through Global Collaborative ATM**					
ASBU B0-10: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	Y	Y	Y	Y	N

ASBU B0 10: Implementation Progress	
Elements	**Implementation Status Air Ground**
1. Airspace planning	Dec.2018
2. Flexible Use of airspace	Dec. 2016
3. Flexible Routing	Dec. 2018

ASBU B0-10: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground system Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. Airspace planning	Lack of organize and manage airspace prior to the time of flight Lack of AIDC		Lack of procedures	
2. Flexible Use of airspace	NIL		Lack of implementation FUA Guidance	
3. Flexible Routing	ADS-C/CPDLC	Lack of FANS 1/A Lack of ACARS	Lack of LOAs and procedures	Poor percentage of fleet approvals

B0-10: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. Airspace planning	Not assigned Indicator and metrics.
2. Flexible Use of airspace	Indicator: % of time segregated airspaces are available for civil operations in the State Supporting Metric: Reduction of delays in time of civil flights.
3. Flexible Routing	Indicator: % of PBN routes implemented Supporting Metric: KG of Fuel savings Supporting Metric: Tons of CO2 reduction

ASBU B0-10: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	Better access to airspace by a reduction of the permanently segregated volumes of airspace.
Capacity	Flexible routing reduces potential congestion on trunk routes and at busy crossing points. The flexible use of airspace gives greater possibilities to separate flights horizontally. PBN helps to reduce route spacing and aircraft separations.
Efficiency	In particular the module will reduce flight length and related fuel burn and emissions. The module will reduce the number of flight diversions and cancellations. It will also better allow avoiding noise sensitive areas.
Environment	Fuel burn and emissions will be reduced
Safety	NA

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MID Regional Planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – B0-20: Improved Flexibility and Efficiency Departure Profiles - Continuous Climb Operations (CCO) **Performance Improvement Area 4: Efficient Flight Path – Through Trajectory-based Operations**					
ASBU B0-20: Improved Flexibility and Efficiency in Departure Profiles (CCO)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	N	Y	N	N

ASBU B0-20: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. CCO implementation	Dec.2017
2. PBN SIDs implementation	Dec.2017

ASBU B0-20: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. CCO implementation			LOAs and Training	In accordance with application requirements
2. PBN SIDs implementation	Airspace Design		LOAs and Training	

ASBU B0-20: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. CCO implementation	Indicator: Percentage of international aerodromes with CCO implemented Supporting metric: Number of international airport with CCO implemented
2. PBN SIDs implementation	Indicator: Percentage of international aerodromes with PBN SIDs implemented Supporting metric: Number of international airport with PBN SIDs implemented

ASBU B0-20: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	
Capacity	
Efficiency	Cost savings through reduced fuel burn and efficient aircraft operating profiles. Reduction in the number of required radio transmissions
Environment	Authorization of operations where noise limitations would otherwise result in operations being curtailed or restricted. Environmental benefits through reduced emissions
Safety	More consistent flight paths. Reduction in the number of required radio transmissions. Lower pilot and air traffic control workload

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MID Regional Planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – B0-(25): FICE Increased Interoperability, Efficiency and Capacity through Ground-Ground Integration **Performance Improvement Area 2:** **Globally Interoperable Systems and Data – Through Globally Interoperable System Wide Information Management**					
ASBU B0-25: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	Y	Y	N	Y

ASBU B0-(25)FICE : Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. Complete AMHS implementation at States still not counting with this system	December 2015 Services provider
2. AMHS interconnection	December 2015 Services provider
3. Implement AIDC /OLDI at MID States automated centres	June 2015 Services provider
4. Implement operational AIDC/OLDI between adjacent ACC´s	June 2018 Services provider
5. Implement new regional network	June 2018 Services provider

ASBU B0-(25) FICE: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. Complete AMHS implementation at States still not counting with this system	NIL	NIL	NIL	NIL
2. AMHS interconnection	TPDI negotiations between MTAs	NIL	NIL	NIL
3. Implement AIDC /OLDI at MID States automated centres	NIL	NIL	NIL	NIL
4. Implement operational AIDC/OLDI between adjacent ACC´s	Compatibility between AIDC or OLDI systems from various manufacturers	NIL	NIL	NIL

ASBU B0-(25) FICE: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
5. Implement new regional network	NIL	NIL	NIL	NIL

ASBU B0-(25) FICE: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. Complete AMHS implementation at States still not counting with this system	Indicator: Percentage of States with AMHS implemented Supporting metric: Number of AMHS installed
2. AMHS interconnection	Indicator: Percentage of States with AMHS interconnected with other AMHS Supporting metric: Number of AMHS interconnections implemented
3. Implement AIDC /OLDI at MID States automated centres	Indicator: Percentage of ATS units with AIDC or OLDI Supporting metric: Number of AIDC or OLDI systems installed
4. Implement operational AIDC/OLDI between adjacent ACC´s	Indicator: Percentage of ACCs with AIDC or OLDI systems interconnection implemented Supporting metric: Number of AIDC interconnections implemented, as per MID Plan
5. Implement new regional network	Indicator: Percentage of phases completed for the implementation of new digital network Supporting metric: Number of implementation phase

ASBU B0-(25) FICE: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	NIL
Capacity	Reduced controller workload and increased data integrity supporting reduced separations translating directly to cross sector or boundary capacity flow increases
Efficiency	The reduced separation can also be used to more frequently offer aircraft flight levels closer to the optimum; in certain cases, this also translates into reduced en-route holding
Environment	NIL
Safety	Better knowledge of more accurate flight plan information

AIR NAVIGATION REPORT FORM (ANRF)

MID Regional Planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – B0-(30) DATM: Service Improvement through Digital Aeronautical Information Management **Performance Improvement Area 2: Globally Interoperable Systems and Data – Through Globally Interoperable System Wide Information Management**					
ASBU B0-(30)DATM : Impact on Main Key Performance Areas					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	N	N	N	Y	Y

ASBU B0-(30) DATM: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. QMS for AIM	Dec.2015
2. e.TOD implementation	Dec.2016
3. WGS-84 implementation	Implemented
4. AIXM implementation	Dec.2018
5. E-AIP implementation	Dec.2015
6. Digital NOTAM	Dec. 2018

ASBU B0-(30) DATM: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. QMS for AIM 2. e-TOD implementation 3. WGS-84 implementation 4. AIXM implementation 5. e-AIP implementation 6. Digital NOTAM	Lack of electronic Database. Lack of electronic access based on Internet protocol services.	NIL	Lack of procedures to allow airlines provide digital AIS data to on-board devices, in particular electronic flight bags (EFBs). Lack of training for AIS/AIM personnel.	NIL

ASBU B0-(30) DATM: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. QMS for AIM	Indicator: % of States QMS Certified Supporting Metric: number of States QMS Certification
2. e-TOD implementation	Indicator: % of States e-TOD Implemented Supporting Metric: number of States with e-TOD Implemented
3. WGS-84 implementation	Indicator: % of States WGS-84 Implemented Supporting Metric: number of States with WGS-84 Implemented
4. AIXM implementation	Indicator: % of States with AIXM implemented Supporting Metric: number of States with AIXM implemented

ASBU B0-(30)DATM: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
5. e-AIP implementation	Indicator: % of States with e-AIP Implemented Supporting Metric: number of States with e-AIP Implemented
6. Digital NOTAM	Indicator: % of States with Digital NOTAM Implemented Supporting Metric: number of States with Digital NOTAM Implemented

ASBU B0-(30) DATM: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	NA
Capacity	NA
Efficiency	NA
Environment	Reduced amount of paper for promulgation of information
Safety	Reduction in the number of possible inconsistencies

AIR NAVIGATION REPORT FORM (ANRF)

MID Regional Planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – B0-(65) APTA: Optimization of Approach Procedures Including Vertical Guidance **Performance Improvement Area 1: Airport Operations**					
ASBU B0-(65) APTA: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	Y	Y	Y	Y	Y

ASBU B0-(65) APTA: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. APV with Baro VNAV	December 2016 – Service Providers and users
2. APV with SBAS	Not applicable
3. APV with GBAS	December 2018 – Initial implementation at some States (services providers)

ASBU B0-65: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground system Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. APV with Baro VNAV	NIL	Insufficient number of equipped aircraft	Insufficient appropriate training	Lack of appropriate training
2. APV with SBAS	Not Applicable	Not applicable	Not applicable	Not applicable
3. APV with GBAS	Lack of cost benefit analysis Adverse ionosphere	Insufficient number of equipped aircraft	Insufficient appropriate training	Lack of appropriate training Evaluation of a real operational requirement

ASBU B0-65: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
1. APV with Baro VNAV	Indicator: Percentage of international aerodromes having instrument runways provided with APV with Baro VNAV procedure implemented Supporting metric: Number of international airport having approved APV with Baro VNAV procedure implemented
2. APV with SBAS	Not Applicable

ASBU B0-(65) APTA: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
3. APV with GBAS	Indicator: Percentage of international aerodromes having instrument runways provided with APV GBAS procedure implemented Supporting metric: Number of international airport having APV GBAS procedure implemented.

ASBU B0-65: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	Increased aerodrome accessibility
Capacity	Increased runway capacity
Efficiency	Reduced fuel burn due to lower minima, fewer diversions, cancellations, delays
Environment	Reduced emissions due to reduced fuel burn
Safety	Increased safety through stabilized approach paths.

AIR NAVIGATION REPORT FORM (ANRF)

MID Regional Planning for ASBU Modules

REGIONAL PERFORMANCE OBJECTIVE – B0-(75) SURF: Safety and Efficiency of Surface Operations (A-SMGCS Level 1-2) **Performance Improvement Area 1: Airport operation**					
ASBU B0-(75) SURF: Impact on Main Key Performance Areas (KPA)					
	Access & Equity	**Capacity**	**Efficiency**	**Environment**	**Safety**
Applicable	Y	Y	Y	Y	Y

B0-75: Implementation Progress	
Elements	**Implementation Status (Ground and Air)**
1. Surveillance system for ground surface movement (PSR, SSR, ADS B or Multilateration)	June 2018 Service provider
2. Surveillance system on board (SSR transponder, ADS B capacity)	June 2018 Service Provider
3. Surveillance system for vehicle	June 2018 Service Provider
4. Visual aids for navigation	December 2015 Service Provider
5. Wild life strike hazard reduction	December 2015 Aerodrome operator/wildlife committee
6. Display and processing information	June 2018 Service Provider

ASBU B0-75: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
1. Surveillance system for ground surface movement (PSR, SSR, ADS B or Multilateration)	NIL	NIL	Lack of procedures and training	Lack of inspector for approvals operations
2. Surveillance system on board (SSR transponder ,ADS B capacity)	NIL	Lack of surveillance system on board (ADS B capacity) On general aviation and some commercial aircraft	Lack of procedures and training	NIL
3. Surveillance system for vehicle	NIL	NIL	Lack of procedures and training	NIL

ASBU B0-75: Implementation Roadblocks/Issues				
Elements	**Implementation Area**			
	Ground System Implementation	**Avionics Implementation**	**Procedures Availability**	**Operational Approvals**
4. Visual aids for navigation	Implementation of new technologies (such as LED) not compliant with Annex 14	NIL	NIL	NIL
5. Wild life strike hazard reduction	NIL	NIL	Lack of Aerodrome Wildlife Committee	NIL

ASBU B0-(75) SURF: Performance Monitoring and Measurement (Implementation)	
Elements	**Performance Indicators/Supporting Metrics**
6. Surveillance system for ground surface movement (PSR, SSR, ADS B or Multilateration)	Indicator: Percentage of international aerodromes with SMR/ SSR Mode S/ ADS-B Multilateration for ground surface movement Supporting metric: Number of international aerodrome with SMR/ SSR Mode S/ ADS-B Multilateration for ground surface movement
7. Surveillance system on board (SSR transponder ,ADS B capacity)	Indicator: Percentage of surveillance system on board (SSR transponder, ADS B capacity) Supporting metric: Number of aircraft with surveillance system on board (SSR transponder ,ADS B capacity)
8. Surveillance system for vehicle	Indicator Percentage of international aerodromes with a cooperative transponder systems on vehicles Supporting metric: Number of vehicle with surveillance system installed
9. Visual aids for navigation	Indicator: Percentage of international aerodromes complying with visual aid requirements as per Annex 14 Supporting metric: Number of international aerodromes complying with visual aid requirements as per Annex 14
10. Wild life strike hazard reduction	Indicator: Percentage of reduction of wildlife incursions Supporting metric: Number of runway incursions due to wild life strike

ASBU B0-(75) SURF: Performance Monitoring and Measurement (Benefits)	
Key Performance Areas	**Benefits**
Access & Equity	Improves portions of the manoeuvring area obscured from view of the control tower for vehicles and aircraft. Ensures equity in ATC handling of surface traffic regardless of the traffic’s position on the international aerodrome
Capacity	Sustained level of aerodrome capacity during periods of reduced visibility
Efficiency	Reduced taxi times through diminished requirements for intermediate holdings based on reliance on visual surveillance only. Reduced fuel burn
Environment	Reduced emissions due to reduced fuel burn
Safety	Reduced runway incursions. Improved response to unsafe situations. Improved situational awareness leading to reduced ATC workload

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