



INTERNATIONAL CIVIL AVIATION ORGANIZATION
South American Regional Office - Regional Project RLA/06/901

*Assistance for the implementation of a regional ATM system according to the
ATM operational concept and the corresponding technological support for CNS*
Tenth Workshop/Meeting of the SAM Implementation Group (SAM/IG/10)
(Lima, Peru, 1-5 October 2012)

SAM/IG/10-WP/06
03/09/12

Agenda Item 3: Implementation of performance-based navigation (PBN) in the SAM Region

**FOLLOW UP OF THE EN-ROUTE PBN ACTION PLAN AND DEFINITION OF
FUTURE PBN IMPLEMENTATION ACTIVITIES IN THE SAM REGION
PURSUANT TO ICAO RESOLUTION A37-11**

(Presented by the Secretariat)

Summary	
<p>This purpose of this working paper is to propose the Meeting to proceed to the final review of the En-route PBN (RNAV5) Action Plan, assess the need for implementation of future specification needs, as established in Resolution A37-11, and also to evaluate all possible benefits of RNAV5 application, keeping in mind its maximum use in terms of routes network optimisation of the SAM Region.</p>	
References:	
<ul style="list-style-type: none">• Annex 11 to the ICAO Convention;• SAM/IG/9 meeting report;• ICAO Assembly Resolution A37-11;• Performance-based air navigation implementation plan for the SAM Region – PBIP, Version 1.0; and• ICAO Doc 9613, Performance Based Navigation(PBN) Manual	
ICAO strategic objectives:	<i>A – Safety</i> <i>C – Environmental protection and sustainable development of air transport</i>

1 Background

1.1 As may be recalled, SAM/IG the group assigned responsible parties and start-up and completion dates for the various activities identified, and adopted the action plan to serve as guidance for States to ensure RNAV5 implementation. These actions, involving an effort by SAM States, users, the SAM Regional Office, and Regional Project RLA/06/901, enabled a successful implementation on **20 October 2011**.

1.2 Taking into account that the main objective of ICAO is to ensure the safe and efficient operation of the global air navigation system, the Eleventh Air Navigation Conference recommended that ICAO develop GNSS RNAV procedures for both fixed-wing and rotary-wing aircraft, to enable reduced operating minima in environments with numerous obstacles or other limitations.

1.3 The 37th ICAO Assembly urged all States to implement air traffic service (ATS) routes and RNAV and RNP approach procedures in accordance with the ICAO PBN concept as defined in the *Performance-based navigation manual* (Doc 9613).

1.4 Consequently, A37-11, which superseded A36-23, resolved that States develop a PBN implementation plan as a matter of urgency in order to achieve a homogeneous implementation in accordance with the established deadlines and intermediate milestones. **Appendix A-I** to this working paper contains a description of the approach procedures, en-route operations, and implementation dates in accordance with Resolution A37-11 and the Regional Performance Objectives (PFF) of the SAM performance-based air navigation implementation plan – PBIP (PFFs are shown in **Appendix A-II**), which shall also be taken into account when developing the PBN Action Plan.

1.5 Within the activities related to the implementation of PBN procedures in the SAM Region, as approved by the Ninth Workshop/Meeting of the SAM Implementation Group (SAM/IG/9), IATA offered support offering the services of Mr Walter White, PBN Expert, in order to participate in the “ICAO PBN Strategy Ad-Hoc Group” Workshop/Meeting, and will also develop a regional PBN planning guide.

1.6 This workshop was carried out at the ICAO SAM Office premises, in Lima, Peru, from 30 July to 03 August 2012, and had the aim to share with ATM community in the SAM Region the lessons learned at a global level in terms of PBN implementation and also to collaborate restructuring the SAM Region PBN Action Plan.

2 Analysis

2.1 During the work week with the IATA expert, the group assessed the current status of PBN implementation in the SAM Region, in order to quantify benefits for airspace users. Also, participants also discussed future aspects of the Region, in order to take advantage of this implementation.

2.2 During the meeting, the Group highlighted that the concept known as 4 corners (**Appendix B**) proposed by Brazil, was not totally compatible for the Region in function of the particular geography and the different operational working methods, which do not enable full application of this concept.

2.3 The group also identified the need to improve operational training of air traffic controllers with respect to PBN concept and the impact which this deficiency provides in aircraft operations, mainly in the approach phase. The PBN concept has a new operations philosophy that should be shared with airline pilots and air traffic controllers, in order to reduce the number of communications, ensuring that the concept is well applied.

2.4 Finally, the group agreed that before going into the next PBN implementation phase, either RNP4 in oceanic areas or RNP2 in continental areas, the Region should assess all possible benefits of RNAV5 application, keeping in mind its maximum use in terms of the routes network optimisation of the SAM Region. In addition, the Group highlighted that States should continue with their efforts in order to analyse fleet navigation capacity for such implementation.

2.5 The meeting will have important tasks. The first task, as identified in the IATA workshop, shall be to evaluate all possible benefits of RNAV5 implementation; then the meeting shall evaluate the need for implementation of RNP4 navigation specifications in oceanic areas or RNP2 in continental areas.

2.6 The last activity will be to update the PBN action plan, in function of decisions taken by the group, as established in Resolution A37-11, **Appendix C**, in order to define coherent terms with regional realities.

3 **Discussion**

3.1 The meeting is invited to:

- a) Take note of the information provided;
- b) Evaluate all possible benefits of RNAV5 implementation;
- c) Evaluate the need for implementation of future navigation specifications, as established in Resolution A37-11;
- d) Update the PBN action plan (**Appendix C**), as established in Resolution A37-11, **Appendix AI**, and with the regional performance framework forms (PFF) of the Performance Based Air Navigation Implementation Plan for the SAM Region – SAM PBIP (PFF are presented in **Appendix A-II**); and
- e) Analyse other considerations deemed pertinent.

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APPENDIX A

DESCRIPTION OF RNAV AND RNP ATS ROUTES, APPROACH PROCEDURES AND DATES OF IMPLEMENTATION IN ACCORDANCE WITH THE ICAO A37-11

I. A37-11 - Performance-based navigation global goals

Whereas a primary objective of ICAO is that of ensuring the safe and efficient performance of the global Air Navigation System;

Whereas the improvement of the performance of the air navigation system on a harmonized, worldwide basis requires the active collaboration of all stakeholders;

Whereas the Eleventh Air Navigation Conference recommended that ICAO, as a matter of urgency, address and progress the issues associated with the introduction of area navigation (RNAV) and required navigation performance (RNP);

Whereas the Eleventh Air Navigation Conference recommended that ICAO develop RNAV procedures supported by global navigation satellite system (GNSS) for fixed wing aircraft, providing high track and velocity-keeping accuracy to maintain separation through curves and enable flexible approach line-ups;

Whereas the Eleventh Air Navigation Conference recommended that ICAO develop RNAV procedures supported by GNSS for both fixed and rotary wing aircraft, enabling lower operating minima in obstacle-rich or otherwise constrained environments;

Whereas Resolution A33-16 requested the Council to develop a programme to encourage States to implement approach procedures with vertical guidance (APV) utilizing such inputs as GNSS or distance measuring equipment (DME)/DME, in accordance with ICAO provisions;

Recognizing that not all airports have the infrastructure to support APV operations and not all aircraft are currently capable of APV;

Recognizing that many States already have the requisite infrastructure and aircraft capable of performing straight-in approaches with lateral guidance (LNAV approaches) based on the RNP specifications and that straight in approaches provide demonstrated and significant safety enhancements over circling approaches;

Recognizing that the Global Aviation Safety Plan has identified Global Safety Initiatives (GSIs) to concentrate on developing a safety strategy for the future that includes the effective use of technology to enhance safety, consistent adoption of industry best practices, alignment of global industry safety strategies and consistent regulatory oversight;

Recognizing that the Global Air Navigation Plan has identified Global Plan Initiatives (GPIs) to concentrate on the incorporation of advanced aircraft navigation capabilities into the air navigation system infrastructure, the optimization of the terminal control area through improved design and management techniques, the optimization of the terminal control area through implementation of RNP and RNAV SIDs and STARs and the optimization of terminal control area to provide for more fuel efficient aircraft operations through FMS-based arrival procedures; and

Recognizing that the continuing development of diverging navigation specifications would result in safety and efficiency impacts and penalties to States and industry;

Noting with satisfaction that planning and implementation regional groups (PIRGs) have completed regional PBN implementation plans; and

Recognizing that not all States have developed a PBN implementation plan by the target date of 2009:

The Assembly:

1. *Urges* all States to implement RNAV and RNP air traffic services (ATS) routes and approach procedures in accordance with the ICAO PBN concept laid down in the *Performance-based Navigation (PBN) Manual* (Doc 9613);
2. *Resolves* that:
 - a) States complete a PBN implementation plan as a matter of urgency to achieve:
 - 1) implementation of RNAV and RNP operations (where required) for en route and terminal areas according to established timelines and intermediate milestones;
 - 2) implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS), including LNAV only minima, for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 per cent by 2010, 70 per cent by 2014; and
 - 3) implementation of straight-in LNAV only procedures, as an exception to 2) above, for instrument runways at aerodromes where there is no local altimeter setting available and where there are no aircraft suitably equipped for APV operations with a maximum certificated take-off mass of 5 700 kg or more;
 - b) ICAO develop a coordinated action plan to assist States in the implementation of PBN and to ensure development and/or maintenance of globally harmonized SARPs, Procedures for Air Navigation Services (PANS) and guidance material including a global harmonized safety assessment methodology to keep pace with operational demands;
3. *Urges* that States include in their PBN implementation plan provisions for implementation of approach procedures with vertical guidance (APV) to all runway end serving aircraft with a maximum certificated take-off mass of 5 700 kg or more, according to established timelines and intermediate milestones;
4. *Instructs* the Council to provide a progress report on PBN implementation to the next ordinary session of the Assembly, as necessary;
5. *Requests* the Planning and Implementation Regional Groups (PIRGs) to include in their work programme the review of status of implementation of PBN by States according to the defined implementation plans and report annually to ICAO any deficiencies that may occur; and
6. *Declares* that this resolution supersedes Resolution A36-23

II. TABLES CONTAINING PERFORMANCE FRAMEWORK FORM (PFF)

REGIONAL PERFORMANCE OBJECTIVE: <u>SAM/ATM 01</u> OPTIMISATION OF THE EN-ROUTE AIRSPACE STRUCTURE				
Benefits				
Safety	<ul style="list-style-type: none">Reduces the complexity of the airspace structure, by reinforcing safety			
Environmental protection and sustainable development of air transport	<ul style="list-style-type: none">Reduces fuel consumption and, consequently, CO² emissions into the atmosphere, due to reduction of miles flown and to continuous descent and ascent operationsIncreases airspace capacity.Takes advantage of aircraft RNAV capacity			
Metrics				
<ul style="list-style-type: none">Reduction of air traffic incidents each 100,00 operations per yearIncrease ATC sector capacityReduction of CO² emissions each 100,00 operations per year				
2012 - 2018 Strategy				
ATM OC COMPONENTS	TASKS	PERIOD	RESPONSIBILITY	STATUS
	a) Carry out implementation and assessment of Version 02 of the SAM ATS route network, and the implementation of RNAV 5 exclusionary space.	(*) - 2013	States	Valid
	b) Optimise oceanic routes and complete implementation of RNAV10 (RNP10) routes.	(*) - 2012	States	Valid
	c) Review and update the SAM PBN Roadmap and the ATS route network optimisation programme.	2012 - 2013	Regional Project States	Valid
	d) Assess the status of implementation of the en-route PBN action plan.	2012	States	Valid
	e) Implement a regional tool for RAI availability forecast in order to support en-route, TMA and non-precision approach operations.	2012 - 2015	States	Valid
	f) Prepare Version 03 of the ATS route network, including RNP4 application for oceanic routes and RNP2 in continental airspace.	2015	Regional Project States	Valid
	g) Implement random routes in defined continental airspaces.	2018+	States	Valid
	h) Monitor implementation progress.	(*) - 2018 +	GREPECAS	Valid
Relationship with GPIs	GPI/5: performance-based navigation, GPI/7: management of dynamic and flexible ATS routes, GPI/8: collaborative airspace design and management.			

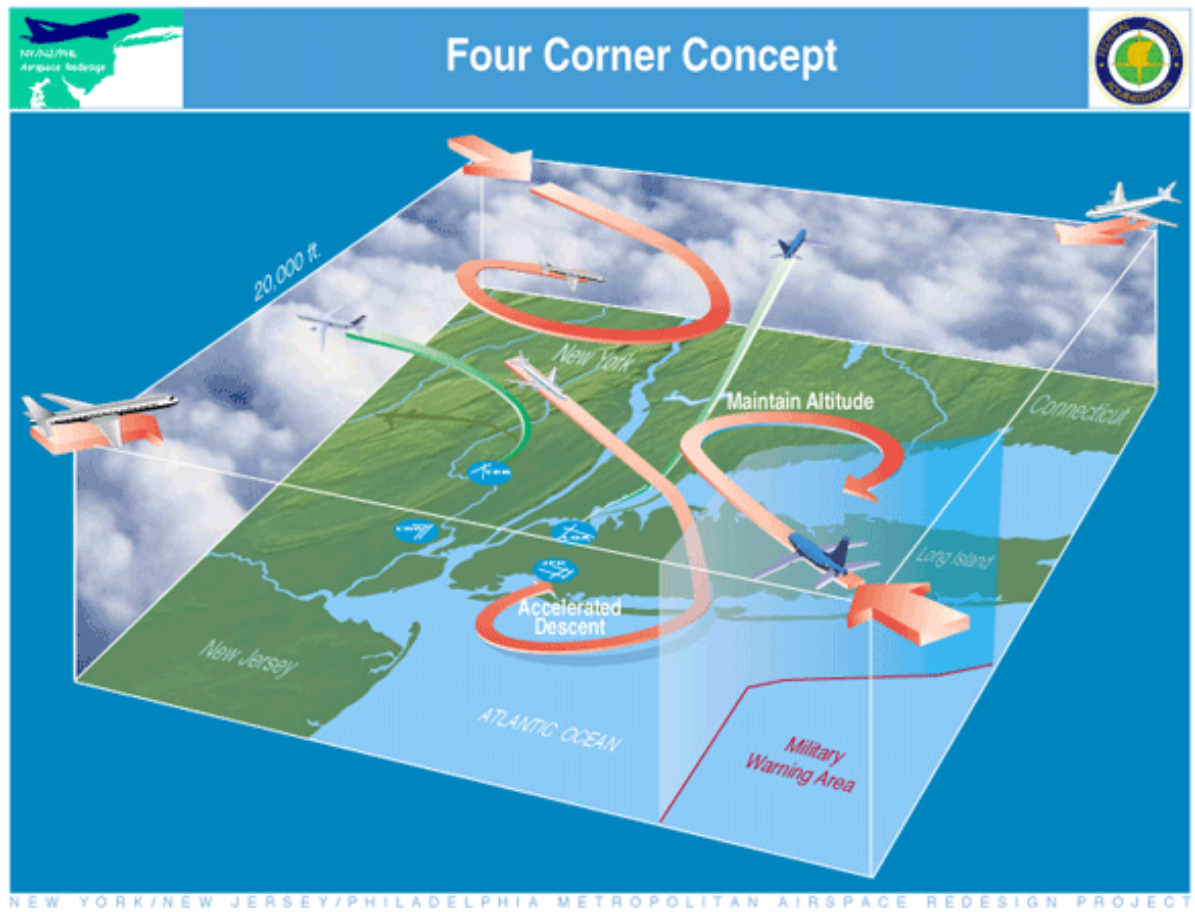
(*) Indicates that the task has started before the date contemplated in this planning.

REGIONAL PERFORMANCE OBJECTIVE: <u>SAM/ATM 02</u> TMA AIRSPACE STRUCTURE OPTIMISATION				
Benefits				
Safety	<ul style="list-style-type: none">• Implementation of continuous descent (CDO) operations• Increased safety during landing and reduced CFIT incidence• Reduction of airspace complexity, by reinforcing safety			
Environmental protection and sustainable development of air transport	<ul style="list-style-type: none">• Reduces fuel consumption and, consequently, CO² emissions into the atmosphere, due to reduction of miles flown and continuous descent and ascent operations;• Reduces aeronautical noise, through continuous descent operations (CDO);• Increases airspace capacity, since it permits the establishment of separate arrival/departure flows, and even the segregation of IFR from VFR flights;• Takes advantage of aircraft RNAV capacity;• Airport arrival/departure under any meteorological condition.			
Metrics				
<ul style="list-style-type: none">• Percentage of international aerodromes with SIDs/STARs, RNAV and/or RNP implemented, when required.• Percentage of aerodromes that have implemented continuous descent and ascent operations.• Reduction of air traffic incidents each 100,00 operations per year• Reduction of tons of CO² emissions each 100,00 operations per year• Reduction of aeronautical noise.				
2012 - 2018 Strategy				
ATM OC COMPONENTS	TASKS	PERIOD	RESPONSIBILITY	STATUS
AOM AUO CM	a) Assess the progress made in the terminal area PBN action plan.	2012	States	Valid
	b) Implement standard RNAV 1 arrival/departure routes in selected TMAs with ATS surveillance.	(*) - 2013	States	Valid
	c) Implement RNAV 1 and/or RNP 1 standard arrival/departure routes in all the TMAs of international airports.	2012 – 2016	States	Valid
	d) Implement CDO operations in all the TMAs of international airports.	2013 - 2018	States	Valid
	e) Implement RNAV1/RNP1 exclusionary airspace in high-density TMAs.	2015 – 2018 +	States	Valid
	f) Monitor progress during implementation.	(*) - 2018	GREPECAS	Valid
Relationship with GPIs	GPI/1: Flexible use of airspace, GPI/5: performance-based navigation, GPI/7: management of dynamic and flexible ATS routes, GPI/8: collaborative airspace design and management, GPI/10: terminal area design and management, GPI/11: RNP and RNAV SIDs and STARs, and GPI/12: functional integration of ground and airborne systems.			

(*) Indicates that the task has been started before the period contemplated in this planning.

REGIONAL PERFORMANCE OBJECTIVE: <u>SAM/ATM 03</u> IMPLEMENTATION OF RNP APPROACHES				
Benefits				
Safety	<ul style="list-style-type: none">Increases safety during landing, reducing the incidence of CFITPermits the establishment of safe approach procedures at airports with limitations due to rough terrain.			
Environmental protection and sustainable development of air transport	<ul style="list-style-type: none">Reduces miles flown and/or permits optimum descent flights, decreasing fuel consumption, and thus CO² emissions into the atmosphere;Takes advantage of aircraft capacity for flying optimum paths;Improved airport operational minima.			
Metrics				
<ul style="list-style-type: none">Percentage of RNP APCH procedures that have been implemented, including APV Baro VNAV and LNAV implemented only at runway ends with instrument operations, according to the 37th Assembly Resolution 37/11.				
2012 - 2018 Strategy				
ATM OC COMPONENTS	TASKS	PERIOD	RESPONSIBILITY	STATUS
AOM AUO AO CM	a) Assess progress of PBN action plan on approach procedures.	2012	SAMIG	Valid
	b) Implement RNP APCH procedures (or RNP AR APCH when operationally advantageous), including APV BARO VNAV, and LNAV only, in conformity with ICAO Assembly Resolution A37/11.	(*) – 2018+	States	Valid
	c) Start-up of the implementation of GLS procedures (GBAS) CAT I landing at selected airports.	2015 – 2018 +	States	Valid
	d) Monitor the progress made during implementation.	(*) - 2018+	GREPECAS	Valid
Relation-ship with GPIs	GPI/1: Flexible use of airspace, GPI/5: performance-based navigation, GPI/8: collaborative airspace design and management, GPI/12: functional integration of ground and airborne systems and GPI/14; runway operations.			

(*) Indicates that the task has been started before the period contemplated in this planning.

APÉNDICE/APPENDIX B**DESCRIPCIÓN DEL CONCEPTO 4 CORNER
DESCRIPTION OF 4 CORNER CONCEPT**

(Four corner concept: Arriving aircraft enter the APP airspace at any of the 4 corners of the square. Departing flights will exit the box on any of the sides. This concept allows controllers to utilize Terminal Control Procedures to a far greater extent. These procedures maximize the use of all available airspace and can reduce existent "bottle necks.")

APPENDIX C – Rev. 1**SHORT-TERM EN-ROUTE PBN ACTION PLAN**
(ASBU x, y, z, ...)

1. Airspace concept	Start	End	Responsible party	Remarks
1.1 Establish and prioritize strategic objectives (safety, environment, etc.)			SAM/PBN/IG (Project RLA/06/901)	
1.2 Collect traffic data in order to understand traffic flows in a given airspace			SAM/PBN/IG (Project RLA/06/901)	
1.3 Analyze the navigation capacity of the aircraft fleet			SAM/PBN/IG (Projects RLA/06/901 and RLA/99/901) States IATA	
1.4 Analyze ground-based means of communication, navigation (VOR, DME) and surveillance to meet navigation specifications and the navigation reversal mode			SAM/PBN/IG (Projects RLA/06/901 and RLA/99/901) States	
1.5 Optimize airspace structure, reorganizing the network or implementing new routes based on the strategic objectives of the airspace concept, taking into account airspace modelling, ATC simulations (fast time and/or real time), live tests, etc.			SAM/PBN/IG (Project RLA/06/901) States IATA	

2	Safety assessment	Start	End	Responsible party	Remarks
2.1	Prepare safety assessment execution using a qualitative methodology through the application of SMS			CARSAMMA Project RLA/06/901 Regional Office	Completed

3	Establish a collaborative decision-making process (CDM)	Start	End	Responsible party	Remarks
3.1	Coordinate planning and implementation requirements with air navigation service providers, regulators, users, aircraft operators and military authorities			SAM/PBN/IG States	
3.2	Establish the implementation date			SAM/PBN/IG States	
3.3	Establish the documentation format in the SAM PBN website			SAM Regional Office	
3.4	Report planning and implementation progress to the corresponding Regional Office. Conclusion to present national plans at SAM/IG/4			SAM/PBN/IG States	

4	ATC automated systems	Start	End	Responsible party	Remarks
4.1	Assess PBN implementation in ATC automated systems, taking into account amendment 1 to the PANS/ATM (FPLSG). Note: It is not a requirement for ... (a ser definida – TBD) implementation			SAM/PBN/IG (Project RLA/06/901)	
4.2	Implement necessary changes in automated ATC systems			States	

5	Aircraft and operator approval	Start	End	Responsible party	Remarks
5.1	Analyze aircraft and operator approval requirements (pilots, dispatchers and maintenance personnel) in keeping with the PBN manual, and develop the necessary documentation.			Regional Project RLA/99/901-Regional Safety Oversight Cooperation System	
5.2	Publish national regulations for the implementation of the ... (a ser definida – TBD) navigation specification			States	
5.3	Approval of aircraft and operators			States	
5.4	Establish and keep up to date a registry of approved aircraft and operators			CARSAMMA States Regional Office	
5.5	Verify the operation of the continuous monitoring programme (aircraft and procedures)			States	

6	Standards and procedures	Start	End	Responsible party	Remarks
6.1	Assess and, if applicable, publish the regulations on the use of GNSS.			SAM/PBN/IG (Project RLA/06/901) States	
6.2	Finalize WGS-84 implementation			States	
6.3	Develop an AIC model to report PBN implementation plans			SAM/PBN/IG (Project RLA/06/901)	
6.4	Publish the AIC reporting PBN implementation plans			States	
6.5	Develop an AIP Supplement model containing applicable standards and procedures, including the corresponding in-flight contingencies			SAM/PBN/IG (Project RLA/06/901)	
6.6	Develop AIP amendment/AIP Supplement Model that contains in the part corresponding to ENR 3.3, including information related to ... (a ser definida – TBD), as well as limitations as regards sensors applicable and critical radio navigation aids of each route segment			SAM/PBN/IG States	
6.7	Publish the AIP Supplement containing applicable standards and procedures, including the corresponding in-flight contingencies			States	
6.8	Review the Procedural Handbook of the ATS units involved			States	
6.9	Update the letters of agreement between ATS units (if necessary).			States	
6.10	Develop an amendment to regional documentation, if necessary			SAM/PBN/IG (Project RLA/06/901)	
6.11	Submit a proposal of amendment to Doc. 7030, if necessary			SAM Regional Office	

7. Training	Start	End	Responsible party	Remarks
7.1 Develop a training and documentation programme for operators (pilots, dispatchers and maintenance personnel)			Regional Project RLA/99/901	
7.2 Develop a training and documentation programme for air traffic controllers and AIS operators			SAM/PBN/IG (Project RLA/06/901)	
7.3 Develop a training programme for regulators (aviation safety inspectors)			RLA/99/901 States	
7.4 Conduct training programmes			States	
7.5 Conduct seminars for operators, explaining plans and expected operational and economic benefits			States	

8. Implementation decision	Start	Responsible party	Remarks
8.1 Assess the available operational documentation (ATS, OPS/AIR)		States	
8.2 Assess the percentage of aircraft and operators ... (a ser definida – TBD) (non-exclusionary airspace)		States	
8.3 Analyze the results of the safety assessment		States	
8.4 Publish trigger NOTAM		States	

9. Performance monitoring system	Start	End	Responsible party	Remarks
9.1 Develop a post-implementation en-route operations monitoring programme			SAM/PBN/IG (Project RLA/06/901)	
9.2 Implement a post-implementation en-route operations monitoring programme			States	
9.3 assess the percentage of ... (a ser definida – TBD) approved operations (non-exclusionary airspace)			SAM/PBN/IG (Project RLA/06/901)	
Pre-operational implementation date				
Definitive implementation date				