International Civil Aviation Organization
South American Office
Third Meeting of Air Navigation and Flight Safety Directors of the SAM Region
(Lima, Peru, 22 to 24 August 2016)

Agenda Item 1: Declaration of Bogota: Follow-up to the implementation of air navigation priorities

FOLLOW-UP TO THE IMPLEMENTATION GOALS ON PBN

(Presented by the Secretariat)

SUMMARY

This working paper presents a report on the evolution of implementation activities related to the projects "*Operational implementation of PBN*" and "*Air navigation systems in support of PBN*" under the PBN Programme, and the implementation goals of the Declaration of Bogota for the SAM Region. These activities are framed under ASBU blocks (B0-APTA, B0-FRTO, B0-CDO, B0-CCO).

References:

- GREPECAS/17 meeting report
- SAMIG/16 and SAMIG/17 meeting reports
- ATSRO/7 meeting report
- PBN implementation workshop reports
- RAAC/14 meeting report
  Fourth Programmes and Project s Review Committee meeting report (PPRC/4)

ICAO Strategic Objectives:	*B - Air Navigation capacity and efficiency* *D - Environmental protection*

1. Introduction

1.1 Pursuant to GREPECAS Decisions 16/45 and 16/47, the Programme entitled "*Performance-Based Navigation (PBN)*" was structured with the following associated projects:

a) Operational implementation of PBN; and
b) Air navigation systems in support of PBN.

2. Discussion

2.1 The progress status of implementation of the project activities that compose Programme A: *Performance-based navigation (PBN)*, are as follows:

Project A1 "Operational PBN Implementation"

2.2 The South American Implementation Group (SAM/IG) Meetings focused mainly on deliverables projected to results on the en-route, TMA and approach phases. Details on main activities of the PBN SAM Project are attached as **Appendix A** to this working paper.

National PBN plans update

2.3 Results achieved to the date of this Meeting indicate that a 77% of States have submitted their updated PBN National Plans. Colombia, Panama and Suriname have not yet updated their PBN Plans. The Secretariat developed a PBN National Plan Model which was distributed among PBN Focal Points of all States in the Region. This regional progress of 50% in regard to AN&FS/2 meeting is reflected in following table:

2016 77%	**ARG**	**BOL**	**BRA**	**CHI**	**COL**	**FGI**	**ECU**	**GUY**	**PAN**	**PAR**	**PER**	**SUR**	**URU**	**VEN**
	YES	YES	YES	YES	NO	YES	YES	YES	NO	YES	YES	NO	YES	YES

PBN en-route

2.4 PBN en-route implementation is discussed in the ATSRO meetings, grounded on the network versions concept, in order to guarantee the best possible airspace structure, within a comprehensive development concept.

2.5 The complete redesign process of the main SAM TMAs has not achieved yet the required maturity level for a comprehensive implementation, which is expected to be reached by 2017, once designs based on PBN of Terminal Areas have been finalized.

2.6 In spite of the above and as an outcome of the teleconferences on routes implementation through Amendment SAM 16/01-ATM and SAM 16/02-ATM, 9 RNAV routes were added, 9 RNAV routes and 1 conventional route were realigned and 16 conventional routes and 1 RNAV were eliminated.

2.7 The Region has continued to progress in the optimization of SAM Region route network, reaching 65% of all routes in the upper airspace. The goal of 60% established in the *Declaration of Bogota* has been exceeded in 5%, as shown in following table:

Total ATS routes upper airspace	**Conventional routes**	**PBN routes**	**% PBN routes implemented**	**Bogota Declaration indicator: % PBN routes**
145	52	93	**65%**	**60%**

Environmental benefits by saving CO_2 during the 2013-2016 period

2.8 Important environmental benefits were achieved during the 2013-2016 period. During 2013, 40,000 tonnes CO_2 were reduced, in 2014 the reduction was of 51,000 tonnes of CO_2 and a reduction of 23,351 tonnes of CO_2 was obtained in 2015. It is expected that during 2016 more annual CO_2 savings will be achieved, and even to surpass the savings obtained during 2015, if the implementation of plans foreseen for this year are met.

2.9 Concerning CO_2 reduction, several States have done a good job at calculating savings resulting from the optimisation of selected airspaces. Most States have used the ICAO IFSET tool. Other States have calculated such savings in collaboration with operators, using more sophisticated tools.

Design based on PBN in Terminal Area (TMA)

2.10 The processes of complete redesign with PBN application in the main South American TMAs are being performed through PBN implementation workshops, under the support of Regional Project RLA/06/901. Since the last AN&FS/2 meeting, four PBN training and follow-up workshops, as well as an implementation workshop for more advanced terminals projects, were carried out.

2.11 PBN optimization in the east-west flows among Argentina, Brazil and Uruguay has been started, but no needed progress has been achieved yet. Nevertheless, this optimization is expected to be completed by the second half of this year, at least with respect to the main traffic flows and the airlift Montevideo-Buenos Aires. These activities have required longer time in coordination for PBN implementation in these airspaces.

2.12 In the PBN workshops, States have recognized that one or more leader airlines' participation in diverse PBN implementation phases helps decision-making processes in collaboration and to improve planning, design and validation phases' results. Nevertheless, there have been unexpected delays in the projects of Colombia, Panama and Paraguay. In all three States this implementation has coincided with updates and implementation of new air traffic control systems, whereby it is expected these delays will be overcome soon.

2.13 A positive aspect to be highlighted is the investment in personnel training in the PANS-OPS area which has been conducted in Argentina, Bolivia, Ecuador and Peru. In the Region, there are some States that still lack from experts trained in PANS-OPS. In such sense, an *ad-hoc* Group has been formed in the SAM/IG meetings, within the PBN Group, to help in solving the problem related to this issue.

2.14 The PANS-OPS *ad-hoc* Group aims to assist States through the PBN Group in the SAM/IG meetings, harmonize publications in the Region, study solutions to problems faced by operators in different scenarios were these procedures are applied, as well as analyze and comment amendments to PANS-OPS documents issued by the Panel and Headquarters.

2.15 In the Region, it has been noticed that States are increasingly using Flight Operations Quality Assurance (FOQA) data for design, and mainly for post-implementation PBN airspace concept assessment, because it offers real data on achieved benefits in those States having leader airlines. Other States are using statistics and radar data.

2.16 SAM Region States are working in the implementation of dates update for Action Plans. The States that have submitted their Action Plans updated for PBN-based redesign in their selected airspace are shown in the table below:

2016 78%	ARG	BOL	BRA	CHI	COL	FGI	ECU	GUY	PAN	PAR	PER	SUR	URU	VEN
	YES	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES	NO	YES	YES

States that have presented their Action plans updated for PBN-based redesign in selected airspaces

2.17 78% of States have presented their Action Plans for selected airspace redesign applying PBN by the date of this Meeting. The goal of 100% is expected to be completed before December 2016.

SID, STAR and PBN Approach Procedures Implementation

2.18 The *Declaration of Bogota* urges States to implement PBN SID and STAR in international airports, in scope to achieve established goals, based on CDO and CCO techniques. Additionally, the mentioned Declaration encourages States to implement APV approach procedures, with a view to comply with ICAO Assembly Resolution A37-11. The data that support the presented information up-to-date on SID, STAR and PBN IAC implementation status is under **Appendix B** to this working paper.

2.19 In the AN&FS/2 meeting, SIDs/STARs implementation in the Region was 64% and up-to-date it can be observed that the PBN SIDs/STARs implementation is of 70%, thus exceeding the *Declaration of Bogota* goal of 60%, as shown in following table:

Total Airports	Total SID/STAR	Total SID/STAR PBN	ICAO Indicator: % SID/STAR PBN in international airports	ICAO Indicator: % SID/STAR PBN in international airports
			August 2016	GOAL 2016
99	1680	1159	70%	60%

2.20 Associated with the designs of arrival and departure procedures, there is the application of CDO and CCO techniques, which have reached following percentages of implementation: CDO 18% and CCO 19%, representing a progress of 13,5% since the AN&FS/2 meeting.

2.21 Concerning the commitment assumed by all States during the 37th ICAO General Assembly according to Resolution A37-11 concerning the implementation of PBN approach, States should intensify efforts to achieve the goal of 100% which should be reached by 2016. The following table shows the current status of implementation.

Total of International Airports	Total thresholds	Total IAP APV or RNP AR or LNAV	ICAO A37-11 indicator % APV per IFR runway	
			Current regional	GOAL 2016
99	175	120	69%	100%

2.22 At the beginning of this implementation, one of the main problems faced by some States in the SAM Region was the lack of procedure designers trained in PBN. SAM Region, through RLA/06/901 Regional Project, has invested heavily in this training, but some States need to make further efforts to achieve the goals set out in Resolution A37-11.

Project A2 "Air navigation systems in support of PBN"

2.23 In Project A2 for the SAM Region, the revision of the practical GBAS system implementation guide is still pending. This guide was foreseen to be submitted in May 2016, but GBAS trials in Brazil have not yet been completed.

2.24 The practical GBAS systems implementation guide review will take place after completing the development of a risk model that accounts for the behavior of the ionosphere at low latitudes. It is expected that such result are to be presented at the Workshop on the implementation of navigation infrastructure to support PBN and GNSS precision approach operations, to be held in Lima, Peru, from 15 to 17 August 2016. Project progress description is shown under **Attachment C** to this working paper.

3. Conclusion

3.1 Under the support of RLA/06/901 Project, direct assistance to SAM Region States for PBN implementation in the selected airspaces has continued. Used tools to this end by the SAM Region have been PBN workshops and implementation meetings (SAM/IG). This strategy has allowed supporting and guiding States of the Region in PBN implementation with several specialized training and implementation workshops.

3.2 The activities on airspace redesign for the SAM Region based on PBN application have a positive impact in the efficiency, safety and in the inclusion of civil aviation authorities, air navigation service providers, air operators, pilots and industry in these processes. However, there are States that have delayed the implementation of their national plans, where problems in projects management could be identified.

3.3 Current status of SAM Region PBN Project since AN&FS/2 meeting (September 2015) up-to-date is the following:

a) Updating of national PBN plans: 77% (the target is 100% by 2016);

b) Annual reduction of CO_2 during the period 2013-2016: important environmental benefits were achieved. During 2013, 40,000 tonnes CO_2 were reduced, in 2014 the reduction was of 51,000 tonnes of CO_2 and a reduction of 23,351 tonnes of CO_2 was obtained during 2015;

c) Implementation of RNAV Routes: 65%, exceeding the target of 60% for 2016;

d) Development of action plans for the redesign of selected airspace applying PBN: 78% (the target is 100% by 2016);

e) Implementation of PBN SIDs/STARs: 70.7%, exceeding the target of 60% set in the *Declaration of Bogota*;

f) Application of CDO and CCO techniques: 18% and 19% respectively, representing a 13.5% improvement since AN&FS/2 meeting;

3.4 Among the factors affecting the fulfilment of goals in the SAM Region, following difficulties can be identified:

a) Scarce availability of PBN procedure designers in 14% of States;

b) Project management failures to meet goals in 28% of States;

c) 14% of States have interrupted the TMA PBN design Project to meet the needs of other ATS projects.

3.5 Appendices A, B and C to this working paper show the description on Project A1 and A2 implementation activities progress for the SAM Region, based on PBN programme approved by GREPECAS.

4. **Suggested action:**

4.1 The Meeting is invited to:

a) take note of the information contained in this working paper; and

b) review project activities and status of implementation in Appendices A, B and C, and formulate other actions as deemed appropriate.

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APPENDIX A

PROJECT A1 - PBN OPERATIONAL IMPLEMENTATION

SAM Region	**PROJECT DESCRIPTION (DP)**	DP N° A1	
Programme	**Title of the Project**	**Start**	**End**
SAM Airspace Optimisation (Programme Coordinator: Roberto Sosa España)	PBN Operational Implementation *Project coordinator:* *Julio de Souza Pereira (IATA)*	2011	2019
Objective	Support the optimisation of the South American airspace structure through the optimisation of the ATS route structure in terminal (RNAV/RNP SIDs/STARs) and en-route (RNAV/RNP) airspace, as well as the implementation of PBN approaches pursuant to ICAO Assembly Resolution A37-11, aiming to achieve the goals established in the Bogota Declaration.		
Scope	The implementation project contemplates the optimisation of the South American airspace through the implementation of PBN and the application of the flexible use of airspace (FUA) concept, as well as the phased optimisation of the ATS route network of the Region.		
Metrics	• Reduction of CO_2 emissions in tonnes for each route optimisation version. • Percentage of RNAV and/or RNP SIDs/STARs implemented at international airports. • Percentage of continuous descent and climb operations implemented at international airports. • Number of RNAV/RNP routes implemented, realigned and/or eliminated. • Percentage of thresholds with APV approaches in international airports.		

Strategy	The conduction of project activities will be coordinated among project members, the Project Coordinator, and the Programme Coordinator, at SAM/IG meetings, ATS route optimisation meetings (ATS/RO) and other events deemed necessary (PBN workshops, hiring of experts, etc.). The Project Coordinator will coordinate with the Programme Coordinator the inclusion of additional experts, if warranted by the tasks and works to be executed. Furthermore, the States must check their respective national PBN implementation programmes for consistency with the PBN Project. Activities involving the review, implementation, modification, or elimination of routes in the SAM Region are foreseen in order to continue with the optimisation of the ATS route structure.
Goals	• Implementation of Version 03 of the ATS route network, based on PBN, to meet the current requirements of airspace users by the end of 2017. • Achieve the goals established in the Bogota Declaration. • 30% of main SAM TMAs redesigned based on PBN by 2016, 50% by 2018. • Development of Version 04 of the ATS Route Network based on PBN and TMAs designed with base on PBN. • Optimisation of longitudinal separation.

Rationale	The 37th ICAO General Assembly established Resolution A37-11 (*Performance-based navigation global goals*), noting that Planning and Implementation Regional Groups (PIRGs) have completed regional PBN implementation plans and urged States to implement 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). It resolved that 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% by 2010, 70% 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. Furthermore, the Global Air Navigation Plan (GANP), Chapter 2 (implementation) establishes Performance-based Air Navigation as its highest priority. The GANP indicates that "*the introduction of PBN procedures has thus far met or exceeded the expectations of the entire aviation community. Current implementation plans should help deliver additional benefits but remain contingent upon adequate training, expert support to States, continued maintenance and development of international SARPs, and closer coordination between States and partnering organizations.*" Thus, this Project provides specialized support and performs close coordination between States and other stakeholders, in order to ensure a harmonized implementation of PBN in all corresponding flight phases: En route, TMA and approach.
Related projects	• Flexible use of airspace. • Automation. • Air navigation systems in support of PBN.

Project deliverables	Relationship with the performance-based regional plan	Responsible party	Status of Implemen-tation*	Delivery date	Comments
Implementation of Version 01 of the ATS route network, based on RNAV, with the necessary PBN values to meet current requirements of airspace users.	B0-FRTO	Alexandre Luiz Dutra Bastos		October 2010	FINALISED
Implementation of RNAV-5 in the SAM Region.	B0-FRTO	Alexandre Luiz Dutra Bastos		October 2011	FINALISED
Action plan for the implementation of Version 02 of ATS route network optimisation.	B0-FRTO	Alexandre Luiz Dutra Bastos		ATS/RO/3	FINALISED

Traffic data to understand airspace traffic flows.	B0-FRTO	ICAO coordinator		SAM/IG/6	FINALISED
Fleet navigation capacity.	PFF SAM ATM 01	Alexandre Luiz Dutra Bastos		SAM/IG/9	FINALISED
Listing of gateways of the main TMAs in the SAM Region.	PFF SAM ATM 02	Alexandre Luiz Dutra Bastos		SAM/IG/9	Support was given to States in the re-design of their TMAs so as to expedite PBN implementation, training their experts in airspace planning. Several States are delayed with their projects.
Letters of Agreement and Contingency with adjacent States	PFF SAM ATM 01	Alexandre Luiz Dutra Bastos		SAM/IG/10	FINALISED
Detailed study of the SAM ATS route network, route network Version 02	B0-FRTO	Alexandre Luiz Dutra Bastos		April 2012	FINALISED
Risk analysis for the implementation of Version 02 of the ATSRO Programme	B0-FRTO	External consultants		SAM/IG/10	FINALISED
SAM Route Network optimisation					
Planning Version 03 - Stage 1	B0-FRTO	External consultants		SAM/IG/14	FINALISED

Implementation Version 03 - Stage 1 - Flow 1 (Argentina - Chile - Paraguay)	B0-FRTO	States SAM Regional Office		April 2015	FINALISED
Implementation Version 03 - Stage 1 - Flow 2 (Argentina - Brazil - Uruguay	B0-FRTO	States SAM Regional Office		March 2017	The optimisation of this traffic flow is delayed.
Implementation Version 03 - Stage 1 - Flow 3 (Panama - CENAMER - Caribbean)	B0-FRTO	States SAM Regional Office		March 2017	Coordination with CAR Region States was initiated.
Implementation Version 03 - Stage 1 - Flow 3 (Brazil - Guyana - French Guiana - Suriname - Venezuela - Caribbean	B0-FRTO	States SAM Regional Office		October 2016	Optimisation of main flows has been coordinated.
Airspace concept Version 03 - Stage 2	B0-FRTO	States SAM Regional Office		ATSRO/7	Main SAM TMA validated PBN airspace concept has been agreed.
Implementation Version 03 - Stage 2	B0-FRTO	States SAM Regional Office		November 2017	Routes that had no direct dependency on TMAs restructurings were implemented.
Operational Concept development on the structure of PBN routes (ATS, SIDs, STARs routes) for the period 2017-2019.	B0-FRTO	States SAM Regional Office		October 2016	Hiring of experts and invitation to States for providing human resources.

Regional strategy and work programme for the implementation of the flexible use of airspace, applying a phased approach, starting with a more dynamic sharing of reserved airspace	B0-FRTO	States SAM Regional Office		2013-2018	Flexible use of airspace is being optimised with the routes optimisation.
Reduction of conventional longitudinal separation from 80 to 40 NM for GNSS equipped aircraft.	B0-FRTO	States SAM Regional Office		2016-2017	This task has advanced greatly it is expected to be completed on time.
Reduction of conventional longitudinal separation from 40 to 20 NM for GNSS equipped aircraft.	B0-FRTO	States SAM Regional Office		2017-2018	
Reduction of conventional longitudinal separation from 20 to 10 NM for scenarios where ATS surveillance systems are used and these systems cover FIRs boundaries considered.	B0-FRTO	States SAM Regional Office		2019	
PBN TMA					
Update PBN implementation action plans for main TMA	PFF SAM ATM 02	States		October 2016	Conclusion SAM/IG/14-6. 78% of States which updated their action plans has been achieved. Colombia, French Guiana and Suriname have not presented their action plan.

Update SID/STAR PBN status of implementation	PFF SAM ATM 02	States		30 June 2015	Update by 30 June and by 31 December annually, according to Conclusion SAM/IG/14-4
Update Table AOP-1	PFF SAM ATM 02	States		TBD	Conclusion SAM/IG/15-3
Approach					
Update IAC APV status of implementation	PFF SAM ATM 03 B0 APTA	States		30 June 2016	Update by 30 June and by 31 December annually, according to Conclusion SAM/IG/14-4. Implementation of RNP APCH procedures with vertical guidance Baro-VNAV or RNP AR APCH, must be informed.
Meetings/Workshops					
SAM/IG/07	PFF SAM ATM	States SAM Regional Office		May 2011	SAM PBN Implementation Group
SAM/IG/08	PFF SAM ATM	States SAM Regional Office		October 2011	SAM PBN Implementation Group

SAM/IG/09	PFF SAM ATM	States SAM Regional Office		May 2012	SAM PBN Implementation Group
SAM/IG/10	PFF SAM ATM	States SAM Regional Office		October 2012	SAM PBN Implementation Group
SAM/IG/11	PFF SAM ATM	States SAM Regional Office		May 2013	SAM PBN Implementation Group
SAM/IG/12	PFF SAM ATM	States SAM Regional Office		October 2013	SAM PBN Implementation Group
SAM/IG/13	PFF SAM ATM	States SAM Regional Office		May 2014	SAM PBN Implementation Group
SAM/IG/14	PFF SAM ATM	States SAM Regional Office		October 2014	SAM PBN Implementation Group
SAM/IG/15	PFF SAM ATM	States SAM Regional Office		May 2015	SAM PBN Implementation Group
SAM/IG/16	PFF SAM ATM	States SAM Regional Office		October 2015	SAM PBN Implementation Group
SAM/IG/17	PFF SAM ATM	States SAM Regional Office		May 2016	SAM PBN Implementation Group

SAM/IG/18	PFF SAM ATM	States SAM Regional Office		October 2016	SAM PBN Implementation Group
ATSRO/03	PFF SAM ATM 03	States SAM Regional Office		July 2011	SAM route network optimisation
ATSRO/04	PFF SAM ATM 03	States SAM Regional Office		July 2012	SAM route network optimisation
ATSRO/05	PFF SAM ATM 03	States SAM Regional Office		July 2013	SAM route network optimisation
ATSRO/06	PFF SAM ATM 03	States SAM Regional Office		October 2014	SAM route network optimisation
ATSRO/07	PFF SAM ATM 03	States SAM Regional Office		October 2015	SAM route network optimisation
ATSRO/08	PFF SAM ATM 03	States SAM Regional Office		July 2016	SAM route network optimisation
Hiring of experts for the consolidation of Version 03 Stage 2 of the SAM ATS route network	PFF SAM ATM 03	States SAM Regional Office		2017	Suspended, expecting meeting for 2017.
Workshop on PBN Airspace Design in the SAM	B0 APTA B0 CCO B0 CDO	States SAM Regional Office		March 2013	Initial training on PBN airspace planning

PBN/1 Workshop	B0 APTA B0 CCO B0 CDO	States SAM Regional Office		May 2014	FINALISED Objective: Training and preliminary PBN design of Asuncion and Bogota TMAs
PBN/2 Workshop	B0 APTA B0 CCO B0 CDO	States SAM Regional Office		September 2014	FINALISED Objective: Preliminary PBN design of main South American TMAs
PBN/ 3 Workshop	B0 APTA B0 CCO B0 CDO	States SAM Regional Office		March 2015	FINALISED Objective: Validation of preliminary PBN design of main South American TMAs
PBN/4 Workshop	B0 APTA B0 CCO B0 CDO	States SAM Regional Office		September 2015	FINALISED Objective: Guide implementation of main South American TMAs
PBN/IMP/1 Workshop	B0 APTA B0 CCO B0 CDO	States SAM Regional Office		April 2016	Review the implementation phase of States with implementation date expected for the first half of 2016.
PBN/IMP/2-PANS-OPS Workshop	B0 APTA B0 CCO B0 CDO	States SAM Regional Office		September 2016	Review the implementation phase of States with implementation date expected for the second half of 2016 and perform related PANS-OPS activities.
Others					
Update and forward national PBN implementation plans	B0 APTA B0 CCO B0 CDO	States		SAM/IG/15	70% of States have fulfilled this task. Bolivia, Colombia, Panama and Suriname are still remaining. Headquarters has requested to forward National PBN implementation plans.

Resources required	Designation of experts in the execution of some of the deliverables.

*

Grey	Task not started
Green	Activity underway as scheduled
Yellow	Activity started with some delay but expected to be completed on time
Red	It has not been possible to implement this activity as scheduled; mitigating measures are required
Blue	Task completed

APPENDIX B

ESTADO/ STATE	IAC							SID		STAR		SID O STAR PBN AIRPORT	CCO	CDO
	LNAV/ VNAV	RNPAR	LNAV/ VNAV o RNP AR	LNAV/ VNAV o RNP AR AIPORT	RNPAR "ONLY" AIRPORT	LNAV	LNAV/ VNAV o RNP AR o LNAV	SID PBN AIRPORT	SID PBN	STAR PBN AIRPORT	STAR PBN			
Argentina	36.00%	0.00%	16.00%	37.50%	0.00%	36.00%	16.00%	17.65%	28.00%	47.06%	48.00%	56.25%	16.67%	20.83%
Bolivia	33.33%	0.00%	33.33%	33.33%	0.00%	33.33%	33.33%	33.33%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Brasil /Brazil	82.26%	4.84%	82.26%	85.71%	10.71%	88.71%	88.52%	92.86%	91.94%	42.86%	46.77%	92.86%	35.42%	35.42%
Chile	60.00%	30.00%	75.00%	62.50%	50.00%	85.00%	85.00%	75.00%	66.67%	87.50%	80.00%	87.50%	35.29%	41.18%
Colombia	0.00%	8.33%	8.33%	9.09%	9.09%	75.00%	75.00%	81.82%	83.33%	66.67%	66.67%	83.33%	0.00%	0.00%
Ecuador	25.00%	50.00%	50.00%	50.00%	37.50%	25.00%	50.00%	37.50%	50.00%	25.00%	50.00%	0.00%	0.00%	25.00%
Guyana Francesa / Fr. Guiana.	0,00%	0,00%	0,00%	0,00%	0,00%	100,00%	100,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Guyana	0,00%	0,00%	0,00%	0,00%	0,00%	75,00%	75,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Panamá	28.57%	57.14%	57.14%	50.00%	40.00%	57.14%	71.43%	20.00%	28.57%	20.00%	28.57%	20.00%	0.00%	0.00%
Paraguay	100.00%	0.00%	100.00%	100.00%	0.00%	100.00%	100.00%	50.00%	50.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Peru	11.11%	77.78%	77.78%	87.50%	75.00%	22.22%	44.44%	12.50%	55.56%	87.50%	77.78%	87.50%	12.50%	12.50%
Suriname	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Uruguay	25.00%	0.00%	25.00%	50.00%	0.00%	100.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Venezuela	100.00%	0.00%	100.00%	100.00%	0.00%	100.00%	100.00%	100.00%	100.00%	0.00%	0.00%	100.00%	0.00%	0.00%
Región SAM / SAM Region	53.41%	13.07%	53.14%	60.82%	18.37%	71.02%	69.14%	57.58%	62.07%	45.00%	43.18%	69.70%	18.06%	19.35%

Explanatory notes:

- LNAV/VNAV - Percentage of IFR thresholds at international airports with at least one LNAV/VNAV procedure, excepting RNP/AR procedures.
- RNP AR - Percentage of IFR thresholds at international airports with at least one RNP AR procedure, excepting other type of LNAV/VNAV procedures.
- LNAV/VNAV or RNP AR - Percentage of IFR thresholds at international airports with at least one LNAV/VNAV procedure, including RNP AR procedures.
- LNAV/VNAV or RNP AR AIPORT – Percentage of airports with at least one LNAV/VNAV procedure, including RNP AR procedures in at least one threshold.
- RNPAR "ONLY" AIRPORT - Percentage of airports with at least one RNP AR procedure, excepting other type of LNAV/VNAV procedures, in at least one threshold.
- LNAV - Percentage of IFR thresholds at international airports with at least one LNAV procedure.
- LNAV/VNAV or RNP AR or LNAV - Percentage of IFR thresholds at international airports with at least one LNAV/VNAV procedure, including RNP AR procedures or one LNAV procedure.
- SID PBN - Percentage of IFR thresholds at international airports with at least one SID PBN.
- SID PBN AIRPORT - Percentage of airports with at least one SID PBN in at least one threshold.
- STAR PBN - Percentage of IFR thresholds at international airports with at least one STAR PBN.
- STAR PBN AIRPORT - Percentage of airports with at least one STAR PBN in at least one threshold.
- SID or STAR PBN AIRPORT - Percentage of airports with at least one SID PBN or one STAR PBN in at least one threshold.
- CCO - Percentage of airports where Continued Climb Operations techniques apply in both, design of procedures as well as its application by air traffic controllers and pilots.
- CDO - Percentage of airports where Continued Descent Operations techniques apply in both, design of procedures as well as its application by air traffic controllers and pilots.

APPENDIX C

PROJECT A2 – AIR NAVIGATION SYSTEMS IN SUPPORT OF PBN

SAM Region	**PROJECT DESCRIPTION (DP)**	**DP N° A2**	
Programme	**Title of the Project**	**Start**	**End**
PBN (*Programme Coordinator: Roberto Sosa España)*	Air navigation systems in support of PBN *Project Coordinator: Julio Pereira (IATA)* *Experts contributing to the project: Alessander Santoro, Andre Jansen, Fabio Augusto Andrade (Brazil), Paulo Vila and Tomas Macedo (Peru), and the SAM/IG SAM PBN Group*	January 2011	November 2016
Objective	Develop guides, conduct analyses and implement services in support of PBN implementation in the SAM Region.		
Scope	Support to PBN implementation in the SAM Region, initially consisting of: • Practical guide for the implementation of GBAS systems. • Analysis of DME/DME coverage to support PBN procedures. • Implementation of a RAIM availability prediction service.		
Metrics	• Drafting of a practical guide for the implementation of a GBAS system. • Analysis of DME/DME coverage in the SAM Region completed. • Availability of a RAIM availability prediction service. • % of States providing the RAIM availability service.		
Strategy	• All activities will be conducted by experts designated by SAM States and organisations participating in the project entitled "*Air navigation systems in support of PBN",* under the management of the project coordinator and the supervision of the programme coordinator. Communications among project members, and between the project coordinator and the programme coordinator shall be done through teleconferences and the Internet. Likewise, the programme coordinator may meet with the project coordinator and the contributing experts at the SAM/IG implementation meetings. • Once the studies have been completed, the results will be sent to the ICAO programme coordinator as a final consolidated document, and to the GREPECAS PPRC for analysis, review and approval.		

Goals	• Guide for the implementation of a GBAS system, by October 2012. (Review November 2016). • Assessment of DME/DME coverage to support PBN procedures, by May 2011. • RAIM availability prediction service in the SAM Region implemented by September 2014. • 11 SAM States with RAIM availability prediction service available by February 2014. • 3 SAM States and one territory with the service available by the end of 2014.
Rationale	• The implementation of PBN procedures for approach, terminal and en-route operations requires the implementation of air navigation systems, services and infrastructure studies, such as the proper installation of DME to support the DME/DME navigation required in the event of failure of the GNSS system, the RAIM availability prediction service to enable the user to know what is RAIM availability for en-route, terminal and approach operations, and the implementation of GBAS systems to support precision landing procedures. • This project contributes to the implementation of SAM PFF CNS 03, ATM 01, ATM 02, and ATM 03 of the *SAM Performance-based navigation system implementation plan (SAM PBIP).*
Related projects	• Implementation of PBN operational aspects.

Project deliverables	**Relationship with the performance-based regional plan and ASBU block 0 modules**	**Responsible party**	**Status of implementa-tion**	**Delivery date**	**Comments**
Develop a practical guide for the implementation of the GBAS system					
Review of practical guide for the implementation of GBAS systems	SAM PFF CNS 03 ANRF B0-APTA(65)	Alessander Santoro (Brazil)		November 2016	The practical guide for the implementation of GBAS systems was presented for review at SAM/IG/8 meeting. Same was circulated to all States of the Region for review and final version was presented at SAM/IG/11 meeting. In order to measure the real impact, a joint work was developed using station SLS-4000 and other 110 GPS L1 and L2 stations installed in Brazil. Data was collected over a period of maximum solar activity, although it has been the lowest in the last 100 years.

Project deliverables	Relationship with the performance-based regional plan and ASBU block 0 modules	Responsible party	Status of implementa-tion	Delivery date	Comments
					From the data obtained, Brazil concluded that to date, SLS-4000 station may not be used in full for CAT 1 operations in low latitude regions, for which ICEA (Instituto de Control del Espacio Aéreo) will continue with the research in cooperation with FAA and the supplier (Honeywell), aiming to develop a risk model capable to support ionosphere behaviour in low latitudes. Brazil will continue with the research in collaboration with universities and Honeywell, aiming to develop a threat model applicable to the SAM Region. Following the results, a review of the practical guide for the implementation of GBAS systems will be conducted. The review of the practical guide for the implementation of GBAS systems will be conducted once the development of a risk model capable to support the ionosphere behaviour in low latitudes has been concluded. The result is expected to be presented at the Workshop on the implementation of the air navigation infrastructure in support of the PBN and GNSS precision approach operations, to be held in Lima, Peru, from 15 to 17 August 2016.

Project deliverables	Relationship with the performance-based regional plan and ASBU block 0 modules	Responsible party	Status of implementa-tion	Delivery date	Comments
Analyse DME/DME and GNSS infrastructure and coverage needed to support PBN implementation					
Analysis of the DME/DME and GNSS infrastructure required to support PBN implementation in the SAM Region	SAM PFF CNS/03 SAM PFF ATM/01 ATM/02 ATM/03 ANRF B0-APTA(65), B0-FRTO(10), B0-CDO(05), and B0-CCO(20)	Fabio Augusto Andrade and Andre Jansen (Brazil) Paulo Vila and Tomas Macedo (Peru)		The coverage study to support RNAV-5 was completed (SAM/IG/8 October 2011)	A *DME/DME coverage study* was presented and reviewed at the SAM/IG/7 meeting (Lima, Peru, 23-27 May 2011). The coverage study was conducted using the EMACS tool and the results were delivered in a KMZ file clearly showing DME/DME coverage over the geographical map of the SAM Region, using *Google Earth*. The study only supports the RNAV-5 procedure.

Project deliverables	Relationship with the performance-based regional plan and ASBU block 0 modules	Responsible party	Status of implementa-tion	Delivery date	Comments
Development of guidance on the use and availability of GNSS performance forecast/validation tools.					
Implementation of a RAIM availability prediction service	SAM PFF CNS/03 SAM PFF ATM/01 ATM/02 ATM/03 B0-APTA(65), B0-FRTO(10), B0-CDO(05), and B0-CCO(20)	Project coordinator PBN Group SAM/IG		November 2014	Two web-based distance courses were conducted on 15 and 16 September 2014, one in English and the other in Spanish, mainly including explanation of the tools contained in the SAM Region RAIM availability prediction service website (SATDIS), the procedure for assigning codes, the import and export of data, and the query and fault resolution procedure. The course was attended by all focal points nominated by the States, as well as by other participants designated by the States. All focal points received from the service provider the respective user name and password to access SATDIS as administrators. The SATDIS website in three languages (Spanish, Portuguese and English) started operating on 17 September 2014. The SATDIS FSAT final acceptance test was conducted on 18 November 2014. The RAIM availability prediction service is operating since 16 November 2014.

Project deliverables	Relationship with the performance-based regional plan and ASBU block 0 modules	Responsible party	Status of implementa-tion	Delivery date	Comments
Monitor activities for the implementation of air navigation systems in support of PBN		ICAO		January 2011 - May 2016	
Resources required	Implementation of the RAIM availability prediction service.				

Grey *- Task not started*
Green *- Activity underway as scheduled*
Yellow *- Activity started with some delay but expected to be completed on time*
Red *- It has not been possible to implement this activity as scheduled; mitigating measures are required*