Implementation Guidance for ADS-B/MLAT and Implementation in the CAR/NAM Regions

ICAO/FAA Workshop on ADS-B and Multilateration Implementation (ADS-B/IMP)
Mexico City, Mexico, 19 to 22 May 2014

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OUTLINE

- Global References
- Guidance Material
- Regional CAR/SAM Guidelines and Strategy
- NAM/CAR Working Group results
- Implementation in the CAR/NAM Regions

Follow-up to First ICAO/FAA Workshop on ADS-B and Multilateration Implementation (Mexico City, 6 to 8 September 2011)

- ✓ Agreement on a homogeneous ADS-B analysis criterion
- ✓ invitation to join the ADS-B Trials and ADS-B Ad-hoc Group implementation/ planning
- ✓ carry out ADS-B trials in a collaborative manner, share the information for analysis and coordination activities among users in order to improve the integrity of this data
- ✓ To consider the use of MLAT/WAM for immediate benefits and ADS-B for medium term benefits as to improve/optimize radar coverage and to cover existing radar coverage gaps.
- ✓ Internal evaluation of their surveillance service and identification of improvements with MLAT or Wide Area Multilateration (WAM)
- ✓ Consider ADS-B in their national plans
- ✓ Consider the operational benefits and opportunities with new surveillance by evaluating airspace and procedures, seeking to use new surveillance techniques to improve operations not possible with current surveillance infrastructure
- ✓ Apply the homogeneous criteria for ADS-B Data analysis to be developed by the ADS-B Ad-hoc Group

Follow-up to ICAO/FAA Workshop on ADS-B and Multilateration Implementation (Mexico City, 6 to 8 September 2011)

- ✓ Follow-up regional guidelines for MLAT and ADS-B implementation such as example Aeronautical Surveillance Manual - Doc 9924 and
- ✓ Follow-up NAM/CAR Working Groups tasks on the Regional Performance Objectives for situational awareness improvements and CNS infrastructure implementation;
- ✓ Considering that training and development of the human resources is an essential factor for the success implementation and conduction of ADS-B and MLAT aspects, CAR States/Territories/International Organizations should identify training needs and their capacity to satisfy these needs.
- ✓ ICAO to promote the establishment of an agreement among CAR States and United States for the continued collaboration between states on ADS-B and Multilateration surveillance harmonization.
- ✓ ICAO to lead the CAR states in the research and planning for the development of regional and targeted implementation of ADS-B that support states improving surveillance and situational awareness and to include cost-sharing for common benefit implementations.

http://www.icao.int/NACC/Documents/Meetings/2011/ADSBMLT/SummaryofDiscussions.pdf

Global References

- Global ATM Operation Concept (Doc 9854)

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- Global Air Navigation Plan (Doc 9750)

↓

- Regional Planning (Doc 8733) - eANP
- Regional Performance Objetives – RPO (NAM/CAR RPBANIP)

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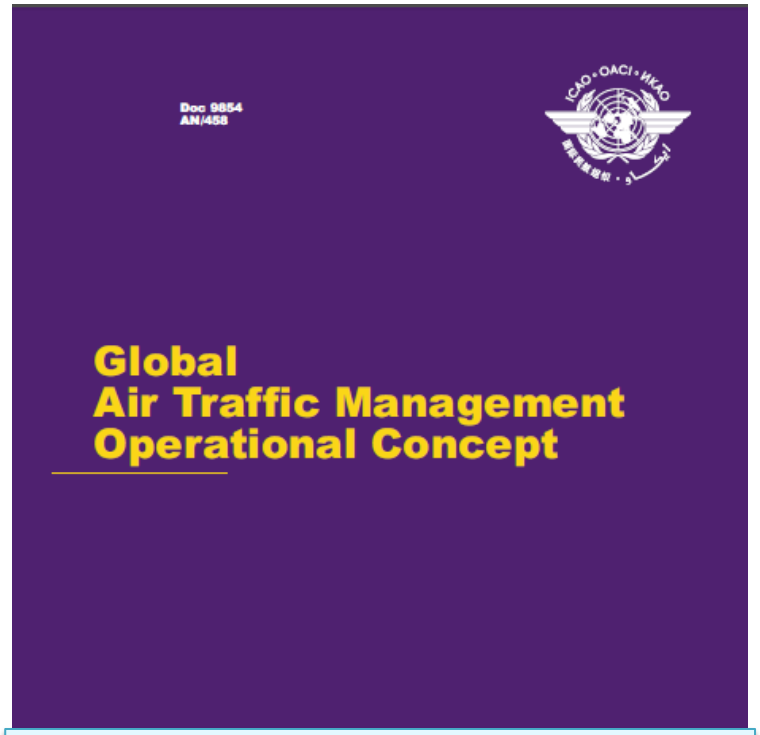
- National Plans

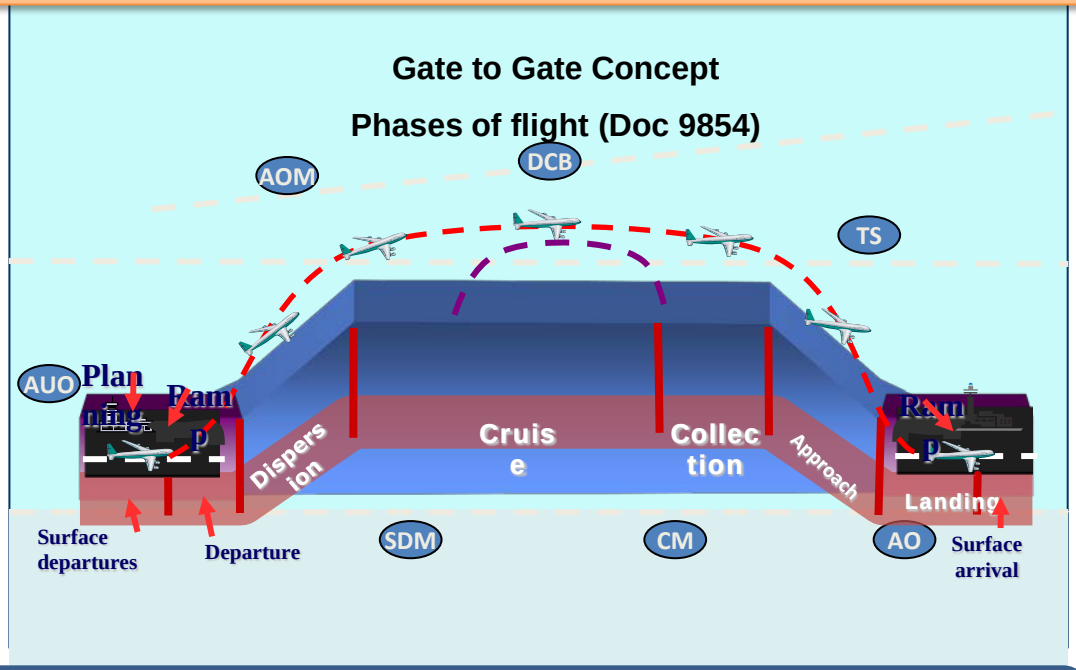
- Global Vision
- Strategic Planning
- Regional Actions
- National Action

Global References



- ✓ Vision of an interoperable, integrated, harmonized and global air traffic management system, for all users during all phases of flight, that meets agreed levels of safety, provides for optimum economic operations, is environmentally sustainable and meets national security requirements.

The ATM system is a system that provides air traffic management through the collaborative integration of humans, information, technology, facilities and services, supported by air, ground and/or space-based communications, navigation and surveillance.



Guide the implementation of CNS/ATM technology by providing a description of how the emerging and future ATM system should operate

Global References

3th Edition
Global Air Navigation Plan (Doc 9750)

(GPI-9) SITUATIONAL AWARENESS

Enhanced surveillance techniques (ADS-C or ADS-B)

reductions in separation minima and an enhancement of safety

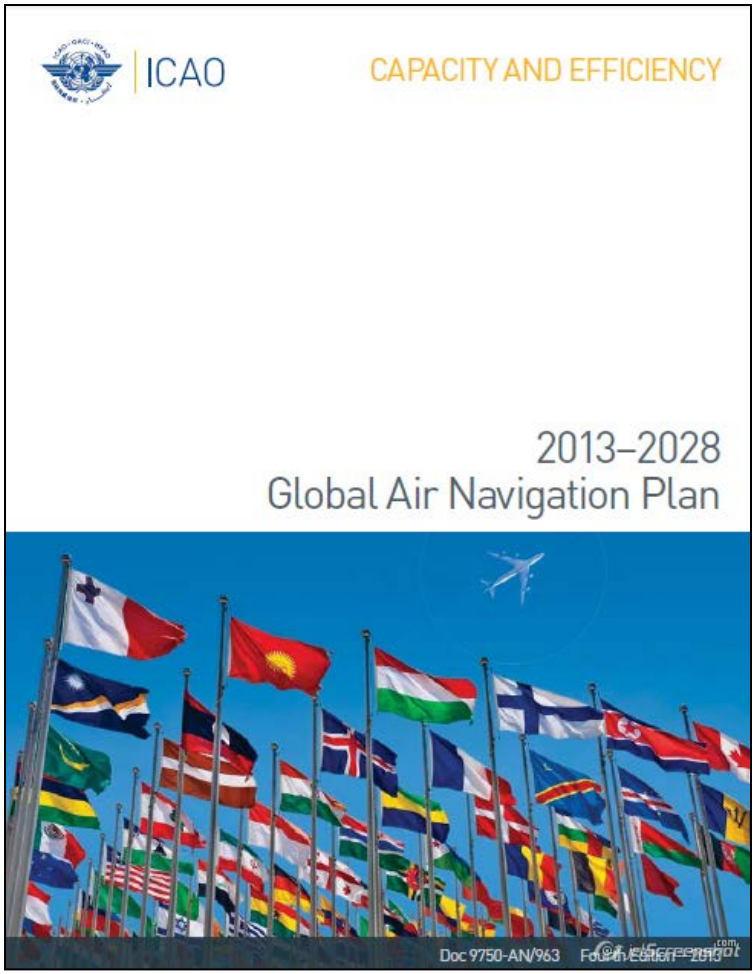
increase in capacity

improved flight efficiency

COST-EFFECTIVE BASIS

- ✓ surveillance to areas where there is no primary or secondary radar
- ✓ in airspaces where radar is used, enhanced surveillance can bring further reductions in aircraft separation minima
- ✓ in high traffic density areas improve the quality of surveillance information (ground/ air), increasing safety levels.
- ✓ quality assured electronic terrain and obstacle data necessary to support the ground proximity warning systems with forward looking terrain avoidance function as well as a minimum safe altitude warning (MSAW) system

Global References



- ✓ ICAO's 15-year Plan
- ✓ ICAO's Ten Key Air Navigation Policy Principles
- ✓ Implementation: ASBU concept
- ✓ CNS/AIM/Avionic Roadmaps
- ✓ State´s experience and practical implementation samples

Guidance Material

STEPS RECOMMENDED FOR PLANNING AND IMPLEMENTATION OF SURVEILLANCE SYSTEMS

a) Define the operational requirements:

- Select applications to be supported
- Define area of coverage
- Define the type of traffic

b) Define local environment (current and future):

- Current and expected future traffic densities
- Route structure
- Type of airborne equipage currently mandated for the different types of flights
- Type of aircraft
- Segregation between the different types of traffic
- Specific local RF environment.

ICAO Aeronautical Surveillance Systems Doc 9924

Guidance Material

c) Analyse design options and determine which techniques can be used

- existing surveillance sensors may be re-used
- new surveillance sensors and techniques may be deployed at lowest cost
- the number of sites and investigate their availability
- the level of redundancy required and fall-back mode of operation
- whether new airborne equipment carriage will be necessary
- impact on operational procedure;
- cost-benefit studies and feasibility analyses

d) Make a safety analysis of the new proposed system:

- To demonstrate that the system will provide the necessary performance in its nominal mode of operation;
- To demonstrate that the different failures have been analysed;
- To demonstrate that they have been found to be either acceptable or can be mitigated.

Guidance Material

e) Implement:

- If new airborne equipment is required, then prepare airborne carriage mandate
- Procure and install the new system
- Evaluate the performance of the new system

f) Establish operational service

- Transition from existing system to the new system

g) Deliver operational service

- Periodically verify the performance of the new system
- Conduct regular and preventive maintenance.

Guidance Material

TRANSITION TO DEPENDENT SURVEILLANCE SYSTEMS

must provide at least the same level of performance required (accuracy, availability, reliability, integrity and update rate) by the existing applications

CONSIDERATIONS:

a) an adequate level of protection against common mode failures

b) fallback surveillance system and/or some operational procedures to accommodate the loss of the GNSS function in an individual aircraft (e.g. due to an equipment malfunction) would be required

c) the possibility of the loss of the GNSS function over an extended area (e.g. due to interference effects on GNSS operation) should be taken into account

d) Validation of the reported ADS-B position

Guidance Material

TRANSITION TO DEPENDENT SURVEILLANCE SYSTEMS

e) in operational environments, where the threat to safety is of significant concern, it should be possible to detect and suppress the creation of tracks on ADS-B reports that contain intentionally incorrect position information; and

f) measures should be in place to cope with the expected growth in traffic over the planned life of the system.

In general, the performance of a surveillance system for a given area and an operational scenario should be specified by the responsible authority. Depending upon the particular airspace and the application, this may imply the need to continue to retain a certain level of SSR operation during the transition period.

Guidance Material

TRANSITION TO DEPENDENT SURVEILLANCE SYSTEMS

Designing a surveillance system

a) need to identify the source of surveillance when information is displayed. -> if the type or condition of the source affects procedures

b) ability to uniquely identify targets

c) impact of the loss of surveillance of individual aircraft: short and long term

d) the impact of the loss of surveillance over an extended area

e) backup or emergency procedures to be applied in the event of aircraft or ground system failure

f) the ability to operate to specification with the expected traffic density

g) the ability to operate in harmony with other systems such as ACAS and ASA

h) the interaction between CNS functions

Guidance Material

Data Transmission and Sharing

ASTERIX specifications
CAT 021- ADS-B target reports

to harmonize the transmission of surveillance information.

Formats:

✓for the exchange of data between the surveillance sensors and data processing systems, and

✓ for the generalized exchange of surveillance data between systems

- ✓ The specification defines the message field content and formats.
- ✓ The messages may be transmitted using any suitable data transport mechanisms such as UDP or TCP.
- ✓ Current set of ASTERIX documents includes categories for the transmission of radar, multilateration, ADS-B and integrated surveillance data.

Guidance Material

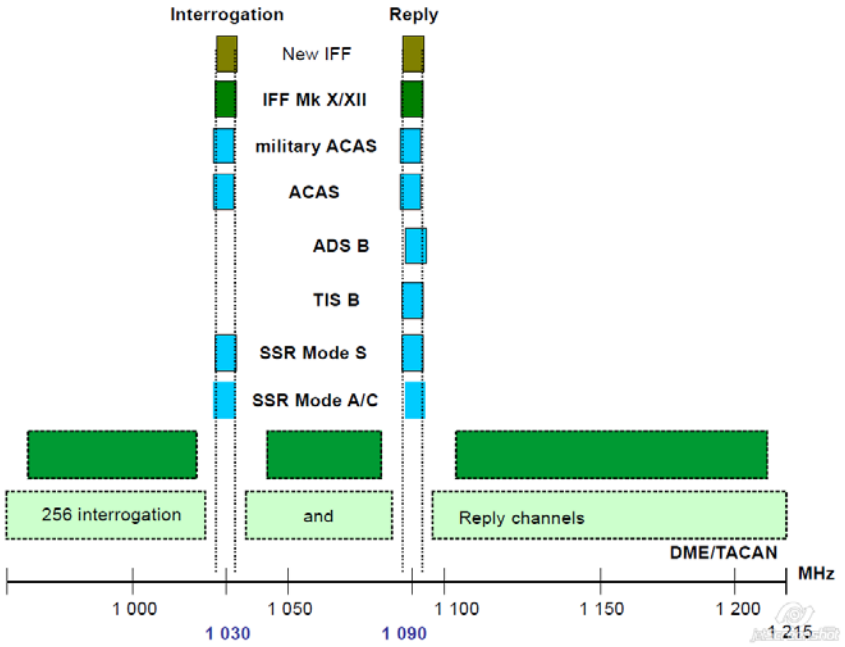
Appendix M: MHz interference considerations

In the ATC environment SSR, ADS-B, ACAS and military of IFF systems use the same frequencies (1 030 MHz and 1 090 MHz)

Interference can result in a degradation of system performance causing lost or wrong information.

The reasons for this degradation are mainly transponder occupancy and RF signal distortion.

maximum rate of 6.2 ES's per second is near the limits in high traffic density areas



Mode S- Cluster/ Selective Interrogation
Coordination with Military users
passive acquisition (e.g. ADS-B and multilateration)

transmission management,
interrogation rate management and
the appropriate antenna design for each system

Regional CAR/SAM Guidelines and Strategy

Reference: CAR/SAM ANP Vol I, Part IV, COMMUNICATIONS, NAVIGATION AND SURVEILLANCE (CNS):

- ✓ It is envisaged that the use of ADS/ADS-B will gradually increase, especially in areas where the provision of radars is not practical or economical.

- ✓ Planning and implementation of surveillance radar systems: CAR/SAM States, during the planning and implementation of new surveillance radar systems or in improving existing facilities, should consider the GREPECAS Guidelines.

- ✓ Planning and implementation of ADS: CAR/SAM States, in coordination with airspace users, should consider the implementation of ADS for providing surveillance in areas in which the provision of radar is not feasible or economical.

Regional CAR/SAM Guidelines and Strategy

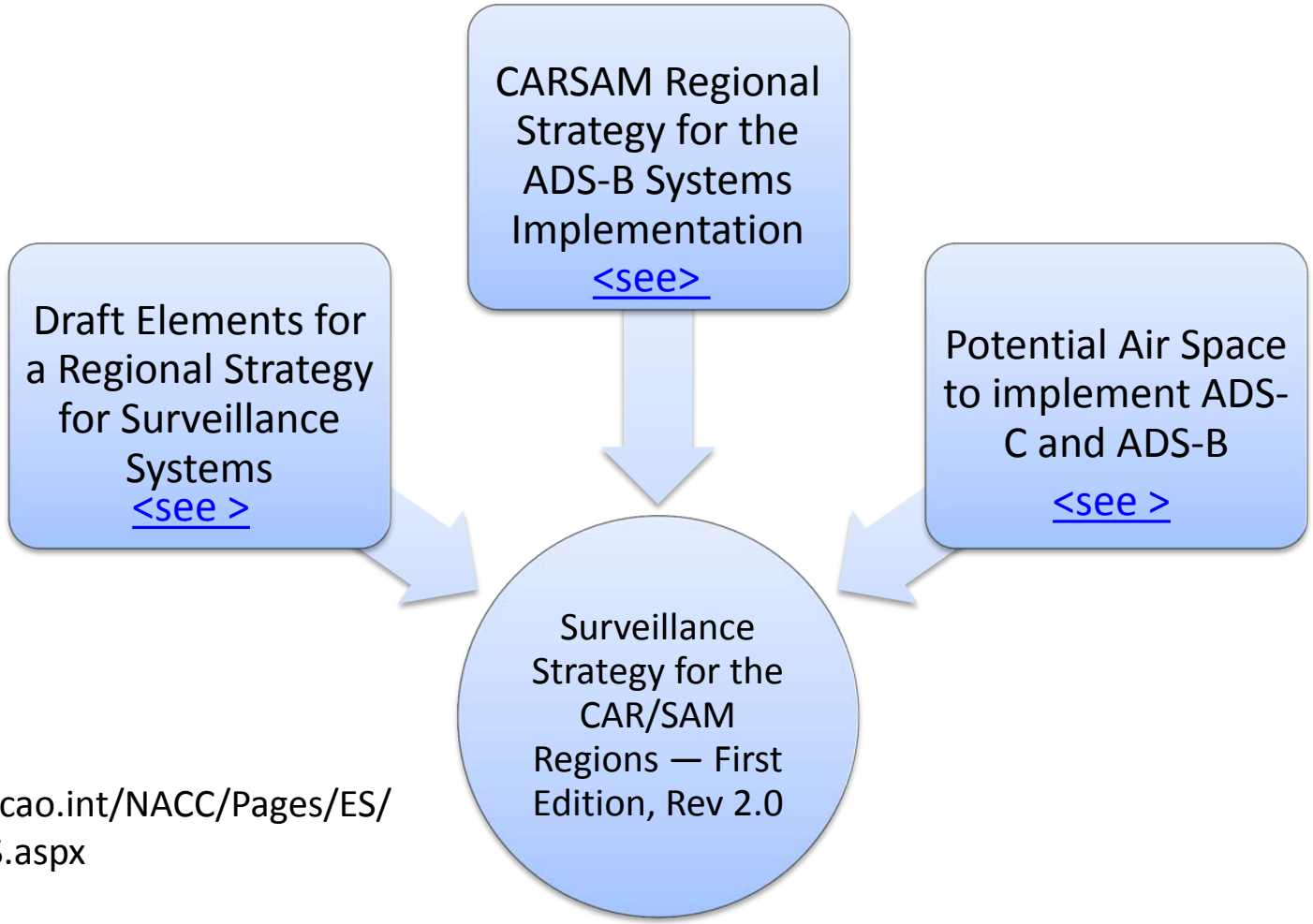
Reference: CAR/SAM ANP, Vol I, Part IV, COMMUNICATIONS, NAVIGATION AND SURVEILLANCE (CNS):

✓ Sharing of radar data: In order to facilitate the implementation of surveillance radar service in a safe, efficient and cost beneficial manner, CAR/SAM States should consider the possibility of bilateral/multilateral arrangements for sharing of radar data between the ATC centres in neighbouring States and the use of a common radar data format and a common communication protocol for radar data exchange in the CAR/SAM regions to be adopted by GREPECAS.

Surveillance Systems (CNS TABLE 4 A)

- Includes the planning for SSR/PSR and ADS systems.
- Last amended in March 2009

Regional CAR/SAM Guidelines and Strategy



http://www.icao.int/NACC/Pages/ES/edocs-cns_ES.aspx

Regional CAR/SAM Guidelines and Strategy

Surveillance Strategy for the CAR/SAM Regions , Rev 2.0

- ✓ the Surveillance Operational Scenario Evolution for short (2009-2010), medium (2010-2015) and long terms (2015-2025) for En-Route and TMA Airspace, Aerodrome Operations and Aircraft Systems.
- ✓ the Surveillance Infrastructure Evolution required to cope with the foreseen operational environment and specifies a tentative action plan

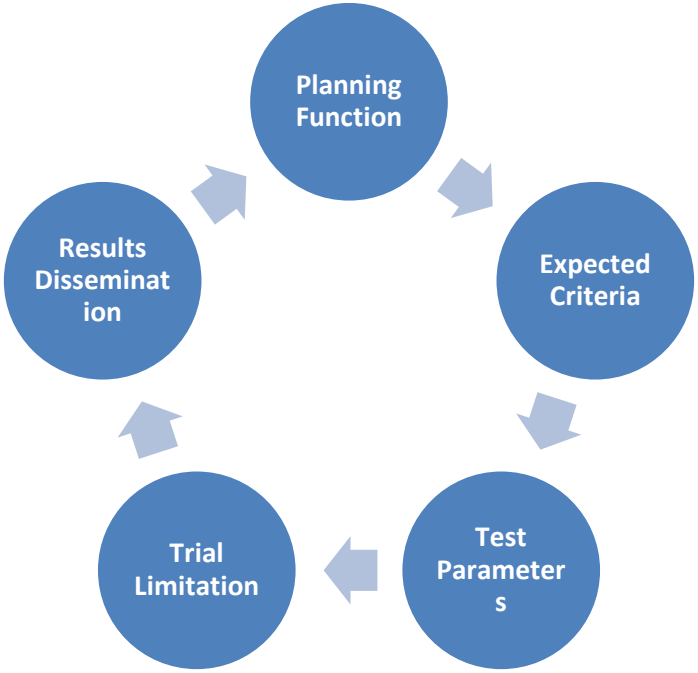
Short term (until 2010)
Until 2010, independent surveillance systems will be predominant in CAR/SAM Regions (ex. SSR, MSSR radars).

Medium term (2010-2015)
From 2010 onwards, the provision of ADDs to ground stations to support TMA and En Route operations is envisaged, following the increasing rate of Mode S equipped aircraft (new and overhauled) that will be able to transmit ADS-B messages (ADS-B out).
The first set of new applications that are envisaged to be supported in CAR/SAM Region are the ground Surveillance (ADS-B out) in a non-radar environment (ADS-B-NRA), in a radar environment (ADS-B-RAD) and Airborne Derived Data (ADS-B-ADD). ADS-B-out is expected to reach full operational capability status in 2015.

Long term (until 2015-2025)
Airborne Surveillance (ADS-B-in, possibly supplemented by TIS-B) including: Airborne situational awareness (ATSA-AIRB), visual separation on approach (ATSA-VSA) and In-trail Procedure in oceanic airspace (ATSA-ITP). ADS-B-in for air traffic situational awareness is expected to be launched after 2015.

Regional CAR/SAM Guidelines and Strategy

ACTIVITIES TO BE CONSIDERED FOR ADS B TRIAL



Planning Function

- ✓ develop a Concept of Operations (CONOPS): scope, the operational requirements, kind of service will be provided in the trial area, the complete schedule to perform the actions required, and the issues that have to be addressed (e.g. efficiency improvement, fuel savings, capacity enhancement, etc.)
- ✓ All stakeholders should be identified and brought to the program by promoting some user and customer conferences, to discuss the contents of the CONOPS and present the benefits of new technologies.
- ✓ It is also important to have some Airline candidates to commit and be part of the program from the beginning.

Regional CAR/SAM Guidelines and Strategy

ACTIVITIES TO BE CONSIDERED FOR ADS B TRIAL

EXPECTED CRITERIA

- ✓ The migration to ADS-B environment should be cost effective
- ✓ The use of the new technology must provide safety benefit
- ✓ The trial must be concluded in a reasonable time frame
- ✓ The ANSPs must get full commitment from users and regulators before the beginning of activities
- ✓ It is important to have some radar coverage (at least partial) over the trial area to validate ADS-B position reports
- ✓ A performance baseline for the designated areas of trials (e.g. existing routes) should be established to make future comparisons possible
- ✓ A Cost Benefit analysis (CBA) should be performed for the customers by the ANSP
- ✓ Data collection should be performed and a safety case based on that data should be presented to Regulators.

Regional CAR/SAM Guidelines and Strategy

ACTIVITIES TO BE CONSIDERED FOR ADS B TRIAL

TEST PARAMETERS

- ✓ Update rate of the prototype system should be measured and compared to the expected rate, depending on the designated airspace (en-route, TMA, ground);
- ✓ accuracy of the system should be evaluated by comparison with a known legacy system (e.g. secondary radars);
- ✓ Performance of the system should be monitored, in terms of NUC (for D260 compatible avionics) or Navigation Integrity Category (NIC), Navigation Accuracy Category (NAC), System Integrity Level (SIL) (for D260A compatible avionics);
- ✓ Probability of reception should also be measured over a very large sampling of flights;
- ✓ Flight ID sent by any aircraft should be assessed by the technical teams;
- ✓ Overall service availability must be measured and determined Anomalies of all types shall be recorded and analyzed.

Regional CAR/SAM Guidelines and Strategy

ACTIVITIES TO BE CONSIDERED FOR ADS B TRIAL

TRIAL LIMITATIONS

- ✓ should be limited to ADS-B out only;
- ✓ validate the performance of the existing communication infrastructure;
- ✓ Monitor spectrum within the trial area: frequency 1090MHz won't be affected for the legacy systems that are currently deployed;
- ✓ It is desirable to have a monitoring system for the health of the GPS constellation to validate its performance during the test event.

RESULTS DISSEMINATION

During the trial processes, a dedicated team should be assigned to collect, organize and analyze data that will be used to write a complete report of the ADS-B trial results

Regional CAR/SAM Guidelines and Strategy

GREPECAS 16/38 C IMPROVEMENTS TO THE ACTIVITIES REFERRED IN ADS-B TRIALS:

That States/Territories/International Organizations who are carrying out ADS-B trials are urged to:

a) Continue with the data collection and analysis, in accordance with GREPECAS guidelines (GREPECAS/15 report, Appendix Q);

b) Search for the exchange of data between States, particularly with regard to coverage superposition and analysis criteria;

c) Solve, with the respective airspace users, the duplicate or illegal 24-bit Address cases identified, and inform in this respect to the ICAO Regional Offices;

d) Inform airspace users on any anomaly in the received ADS-B messages, in preparation of future ADS-B implementation; and

e) Duly inform the ICAO Regional Offices on the trial results, for their publication.

NACC/WG CONCLUSION 3/6 ADS-B TRIALS AND ANALYSIS IN THE CAR REGION

That, in order to consolidate ADS-B activities to have homogeneous criteria in the analysis and data exchange:

a) States/Territories/COCESNA, who are carrying out ADS-B trials, or who have near term plans to do so:

i. inform the ICAO NACC Regional Office about these trials or plans by **31 December 2011;**

ii. designate a point-of-contact to coordinate these activities and notify this information to the ICAO NACC Regional Office;

iii. consider the technical support and assistance offered by the United States on these activities;

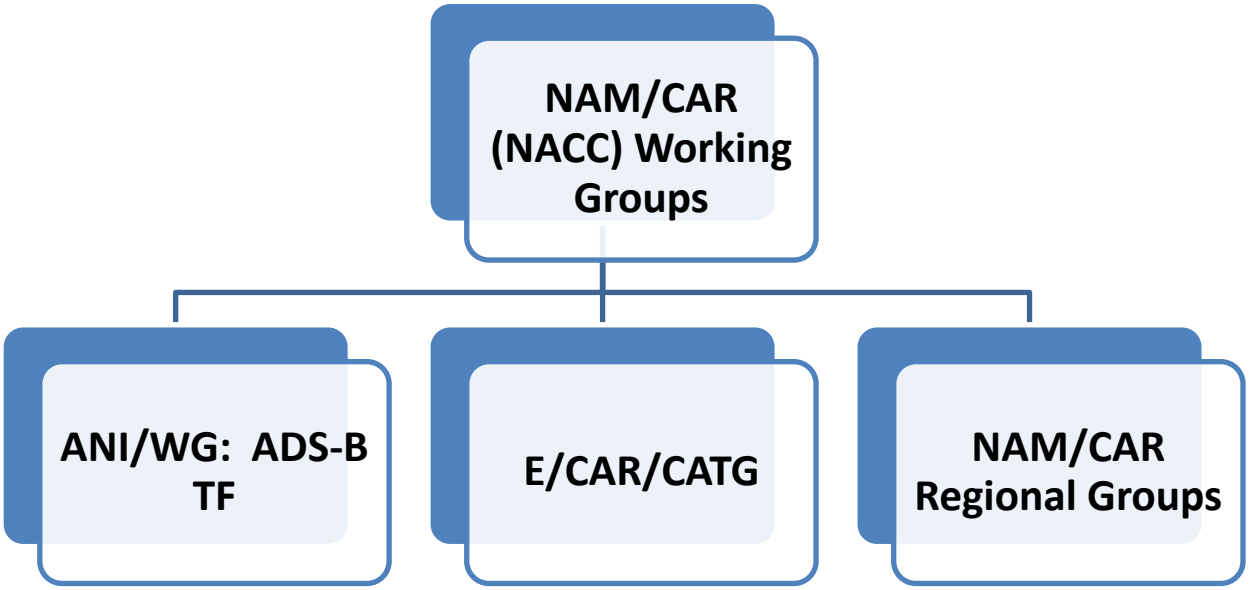
iv. report their progress to the ICAO NACC Regional Office for **31 December 2012;**

b) the ICAO NACC Regional Office:

i. support coordination with users (IATA/ALTA) for their participation in these trial activities; and

ii. provide assistance to participating States with the development and definition of this homogeneous analysis criteria as well as with the activities mentioned in item a).

NAM/CAR Working Group results



NAM/CAR Regional Performance Based Air Navigation Implementation Plan (NAM/CAR RPBANIP) ver. 3.1

NAM/CAR Working Group results

4. IMPROVE SITUATIONAL AWARENESS	
Benefits	
Efficiency	• Enhanced traffic surveillance • Enhanced collaboration between flight crews and the ATM system • Improved collaborative decision-making through electronic aeronautical data sharing • Reduced workload for both pilots and controllers

6. OPTIMIZATION AND MODERNIZATION OF COMMUNICATION INFRASTRUCTURE	
Benefits	
Efficiency	• Improved ATS coordination • Increased communications availability • Communication misunderstandings avoided • Facilitated utilization of advanced technologies
Continuity	• Improved airspace interoperability and seamlessness • Improved provision of air traffic control services to all aircraft operations
Safety	• Improved airspace and aerodrome safety

Strategy

ATM Component	TASK DESCRIPTION	START-END	RESPON-SIBLE	STATUS
AO, TS, CM, AUO AOM, SDM	a) Review the performance status of current AFS services and identify deficiencies or improvements (AFTN, oral ATS services, A/G communications)	2013-2015	States, Territories	Valid
	b) Implement communication service improvements as required to support current and planned Air Navigation applications, including Required Communication Performance (RCPs).	2014-2018	States, Territories	Valid
	c) Develop regional ATN planning documents	2013-2015	GREPECAS	Valid
	d) Coordinate and test ATN G-G application implementation aspects (AMHS, AIDC, etc.)	2013-2018	States, Territories	Valid
	e) Conduct planning, trial and implementation activities for A-G data applications (DCL, D-ATIS, etc.)	2014-2018	States, Territories	Valid
	f) Carry out technical review of regional telecommunication networks for ATN implementation	2013-2015	States, Territories	Valid
	g) Implement available technologies in order to facilitate ground and airborne applications (CPDLC, ADS-C, ADS-B)	2013-2018	States, Territories	Valid
	h) Implement the necessary communications network for ACDM	2014-2018	States, Territories	Valid
	i) Support ICAO position during the ITU WRC and ensure regional coordination for the protection of the aviation spectrum	2013-2018	States, Territories	Valid
	i) Implement data link surveillance technologies and applications as required: ADS , CPDLC, AIDC	2014- 2018	States, Territories, Int. Oper.	Valid

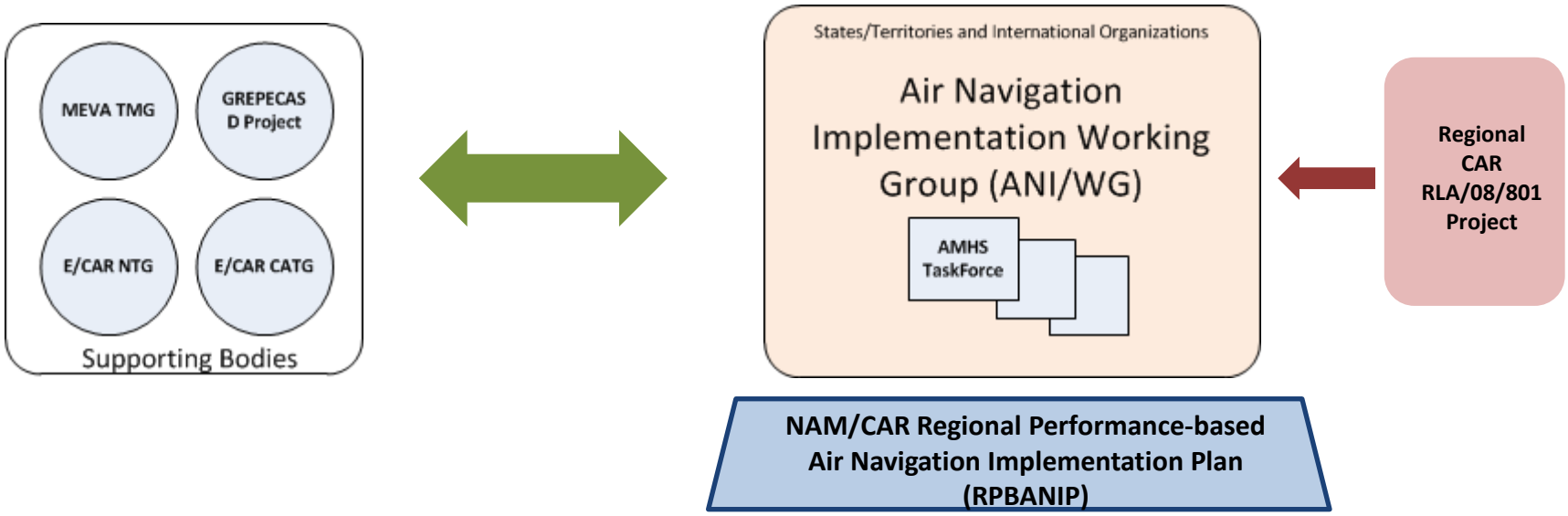
NAM/CAR Working Group results

ASBU B0-75/SURF: Planning Targets and Implementation Progress	
Elements	Targets and Implementation Progress (Ground and Air)
1. Surveillance System for Ground Surface Movement (PSR, SSR, ADS-B or Multilateration)	30% of selected aerodromes with SMR/ SSR Mode S/ ADS-B Multilateration for ground surface movement by June 2018
1. On-board Surveillance Systems (SSR transponder, ADS B capacity)	20% of aircraft on the NAM/CAR State registries to have surveillance system on board (SSR transponder, ADS B capacity) by June 2018
1. Surveillance System for Vehicles	20% of vehicles at selected aerodromes with a cooperative transponder systems by June 2018

ASBU B0-84/ASUR: Planning Targets and Implementation Progress	
Elements	Targets and Implementation Progress (Ground and Air)
1. Implementation of ADS-B	30% of selected aerodromes with ADS-B implemented by Dec 2018
1. Implementation of Multilateration	80% of multilateration system implemented in selected aerodromes by June 2018

NAM/CAR Working Group results

NAM/CAR Implementation supporting and implementing Bodies



http://www.icao.int/NACC/Pages/nacc-regionalgroups-aniwg.aspx

ADS-B, AIDC, AIM, AMHS, ATFM, GOLD (CPDLC) and PBN, TaskForces
Responsibilities/ Work Programme/ Membership

NAM/CAR Working Group results

ANIWG/01 Results

Creation of the ADS-B Task Force (ToR, Work programme and Membership)

ADS-B receivers specifications for CAR Project Acquisition

GREPECAS Project C – *Automation and improve ATM situational awareness: developing* Guidelines on the operational implementation of ADS-B and data exchange

IATA expressed full support for ADS-B implementation and requested that ANSPs inform on implementation in a timely manner and provide user benefits of ADS-B

2012 Avionic Equipage Survey-2012

ADS-B Action Plan, Initial Points of Contact and reorganization of ADS-B Adhoc-Group

NAM/CAR Working Group results

NACC/WG/04 Results

Review of ADS-B TF activities

States and ANSPs´ progress on ADS-B

Agreement for 2nd ADS-B/MLAT Workshop

CONCLUSION NACC/WG/4/10 ADS-B OUT IMPLEMENTATION IN THE NAM/CAR REGIONS

That all States/Territories in the NAM/CAR Region adopt/include in their implementation plans the ADS-B implementation date by **31 December 2018**, to finalize the operational implementation of ADS-B out.

Implementation in the CAR/NAM Regions

Review of Radar Data Processing and Exchange implementation

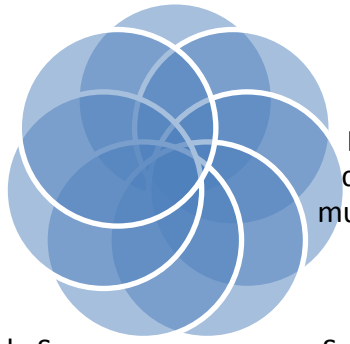
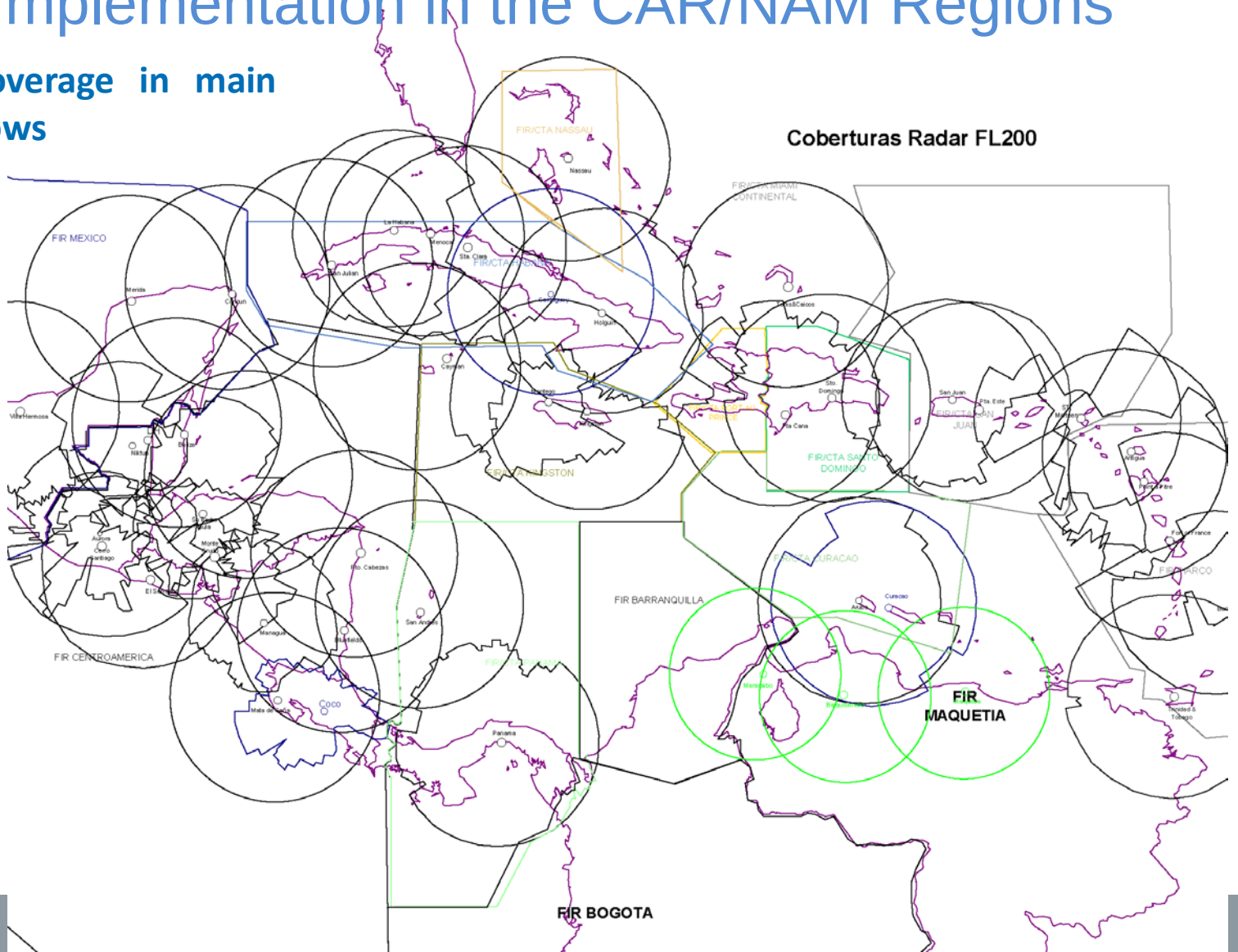


Table CNS 4 – Surveillance Plan- MSSR/MSSS	☑
Agreements- bilateral	☑
Ensure RTQM and Performance/ Surveillance reliability and integrity criteria	On-going
Notification of surveillance identifier (SI) codes/ Interrogator identifier (II) codes	On-going
Automation – Data Processing	☑
Telecommunication media	☑
Radar data exchange with SAM Adjacent FIRs	On-going

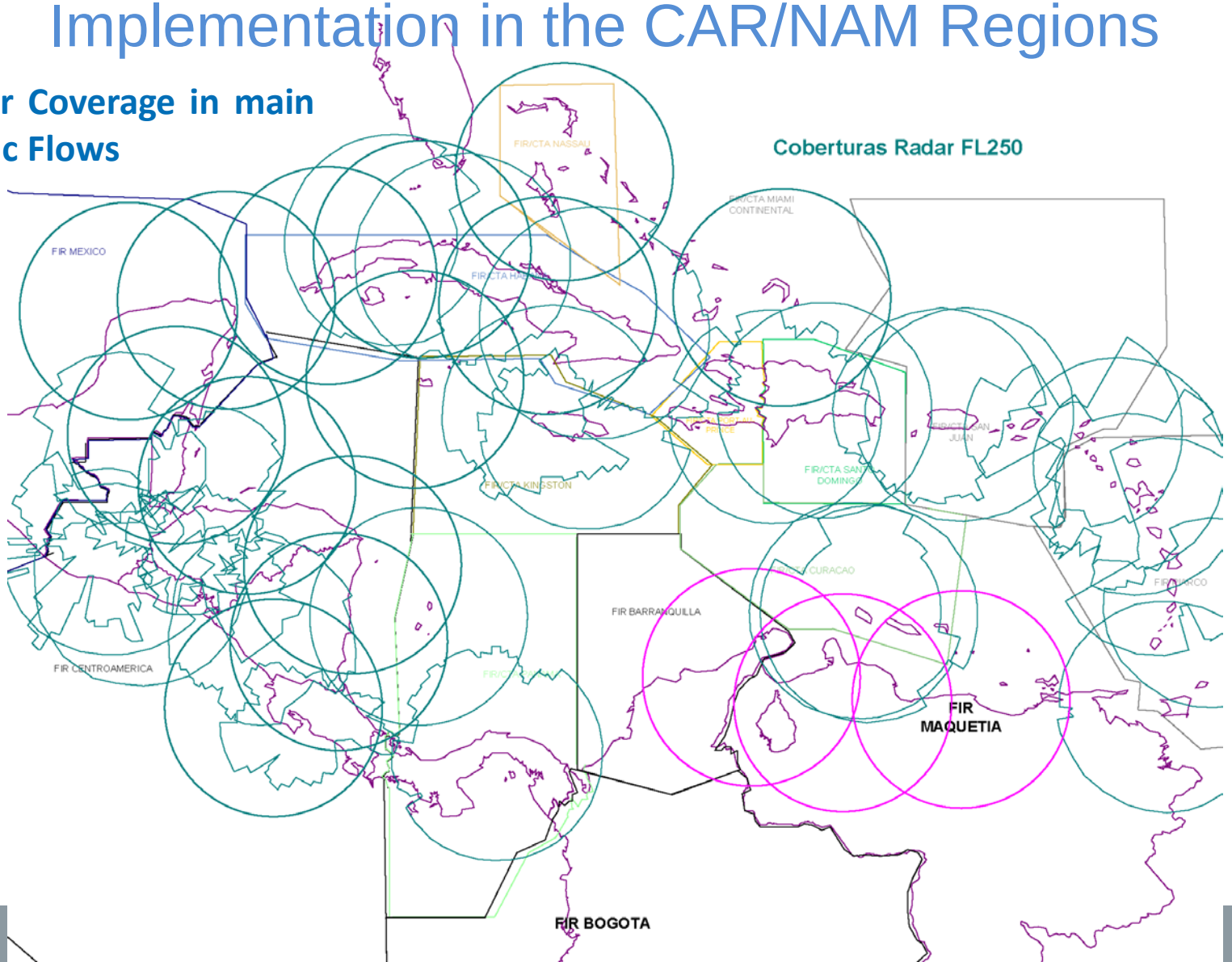
Implementation in the CAR/NAM Regions

Radar Coverage in main Traffic Flows



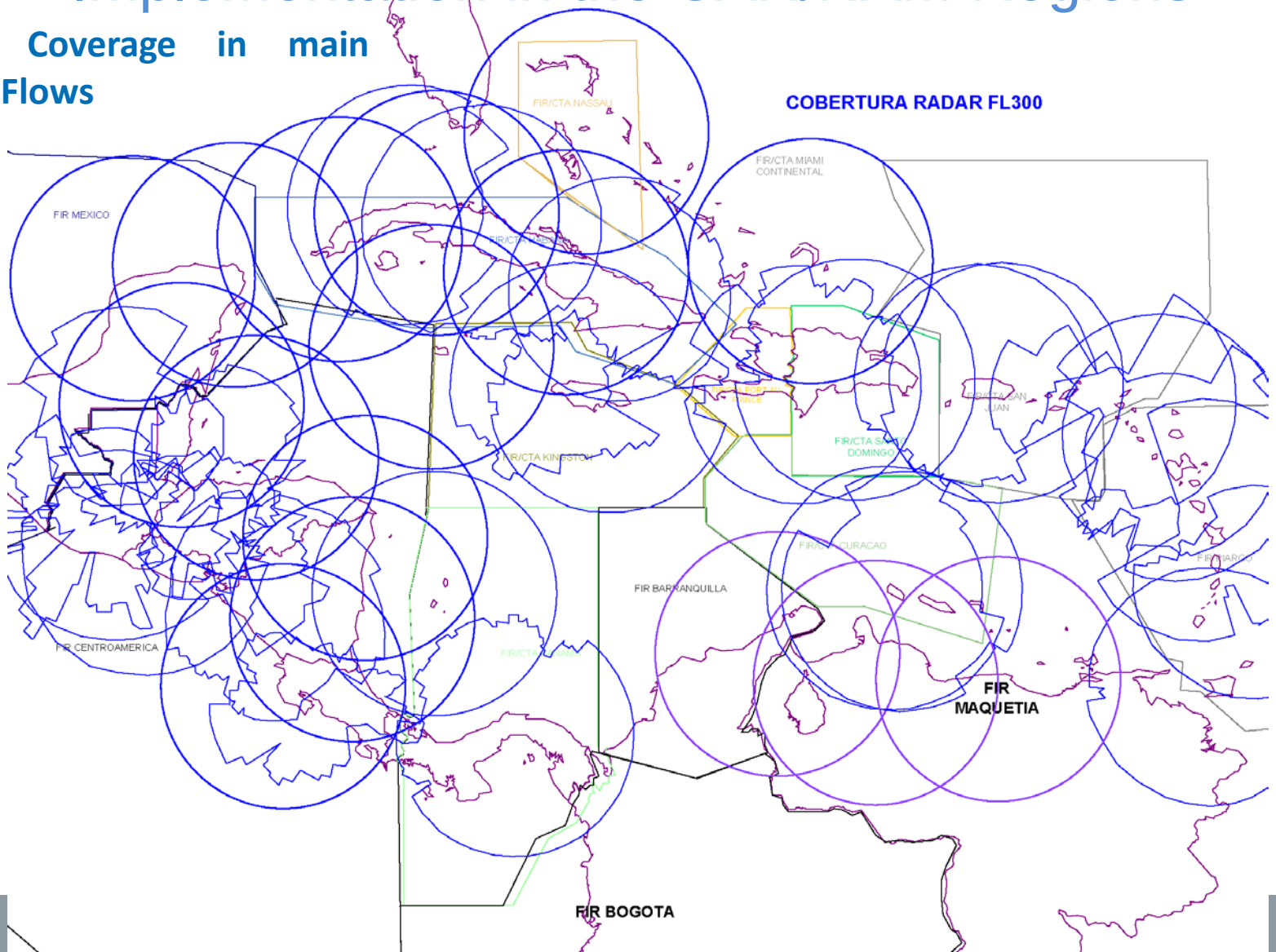
Implementation in the CAR/NAM Regions

Radar Coverage in main Traffic Flows



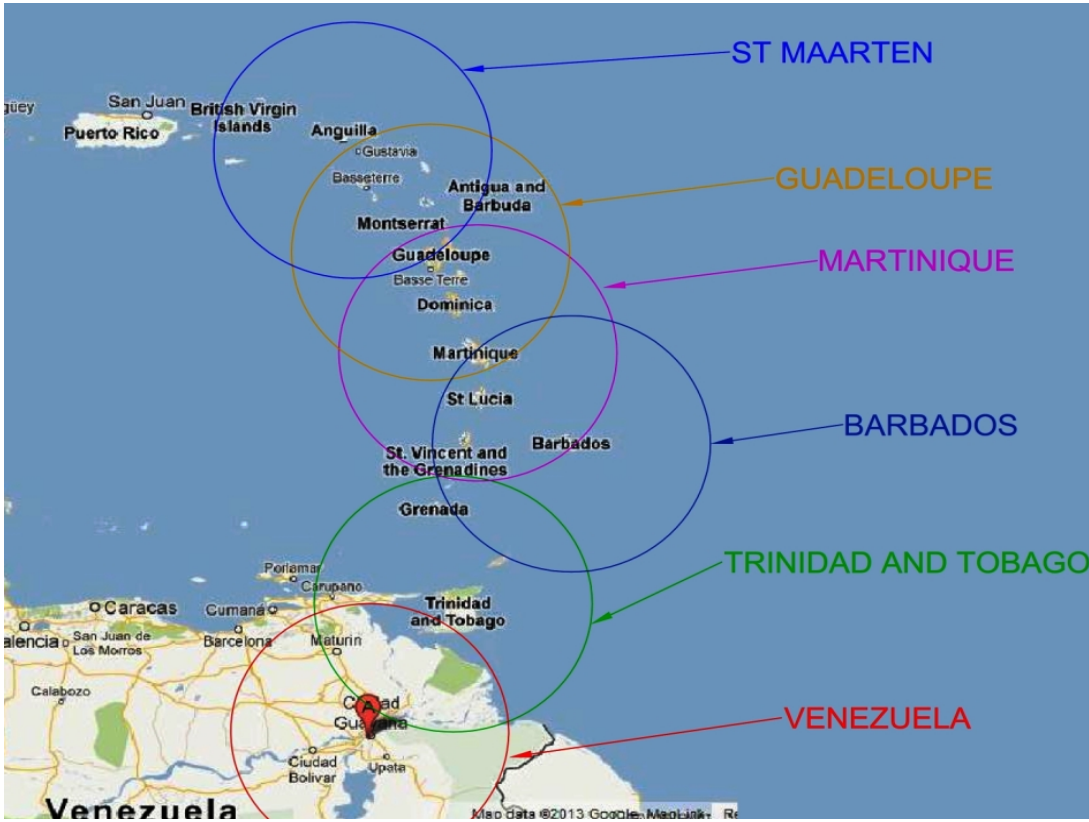
Implementation in the CAR/NAM Regions

Radar Coverage in main Traffic Flows



Implementation in the CAR/NAM Regions

- Radar data sharing implemented through the E/CAR AFS network
- Trinidad and Tobago provides and hosts the radar data server for the sharing of radar data in the Eastern Caribbean
  - The radar data from Martinique and Guadeloupe radars are presently available at the Piarco ACC in addition to the Trinidad and Tobago radar data.
  - Through multi sensor fusion the Piarco ATM system will process and distribute via the E/CAR AFS network a seamless composite surveillance image to the E/CAR states.
- Radar Data Display implementation in E/CAR States – system tracks /E/CAR Radar Data Sharing Ad-hoc Group)



Implementation in the CAR/NAM Regions

Status of Radar Data Exchange implementation: Operational

- ✓ Within Central America (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, COCESNA)
- ✓ Mexico / Central America
- ✓ Central America/ Panama
- ✓ Mexico / USA
- ✓ Cuba/ Central America
- ✓ French Antilles / Saint Lucia / Trinidad & Tobago

Implementation in the CAR/NAM Regions

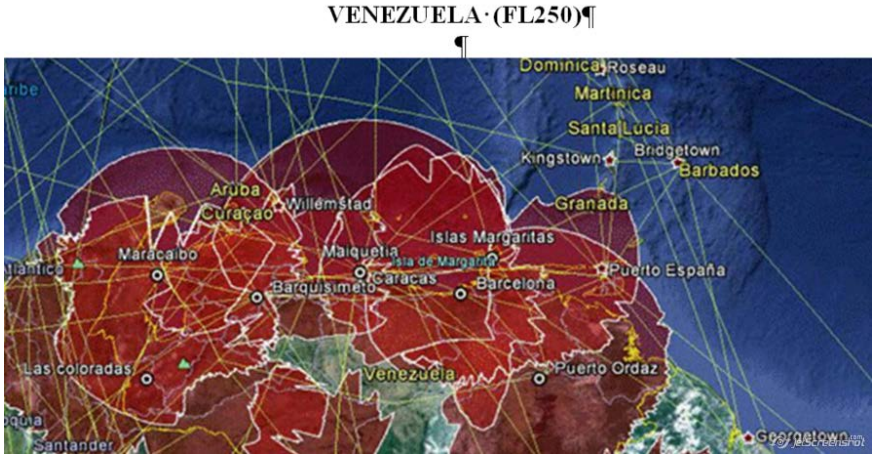
Status of Radar Data Exchange implementation: On going

- Jamaica/Central America: testing
- Cuba/ Jamaica: testing
- Sint Maarten/ Trinidad and Tobago: Pending
  - several teleconferences
  - Action Plan agreed
- Cuba/Mexico: Pending agreement
- Barbados/Trinidad & Tobago: Pending
- Antigua Radar reactivation: Pending
- Dominican Republic/Curacao: Pending

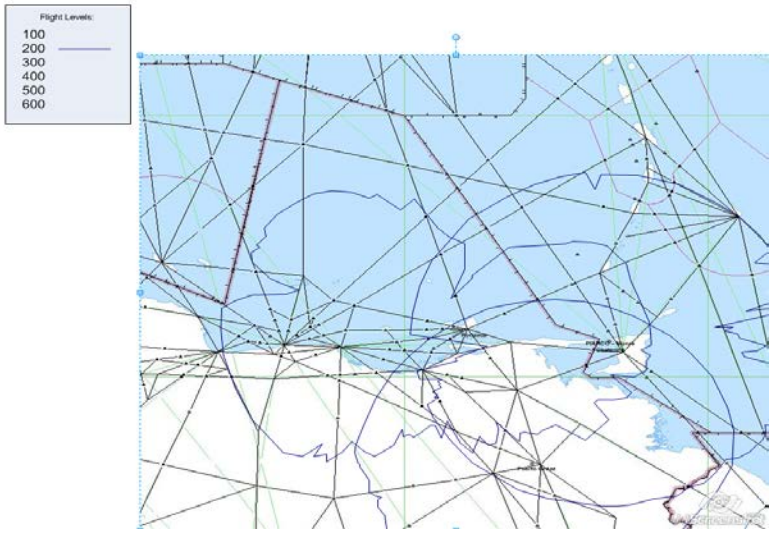
Implementation in the CAR/NAM Regions

Status of Radar Data Exchange implementation: On going

- Curacao/ Venezuela: Pending
  - 2 teleconferences
  - Action Plan agreed



- Curacao/ Trinidad and Tobago: Pending
  - 4 teleconferences
  - Action Plan Agreed



Implementation in the CAR/NAM Regions

Status of Radar Data Exchange implementation: Future considerations

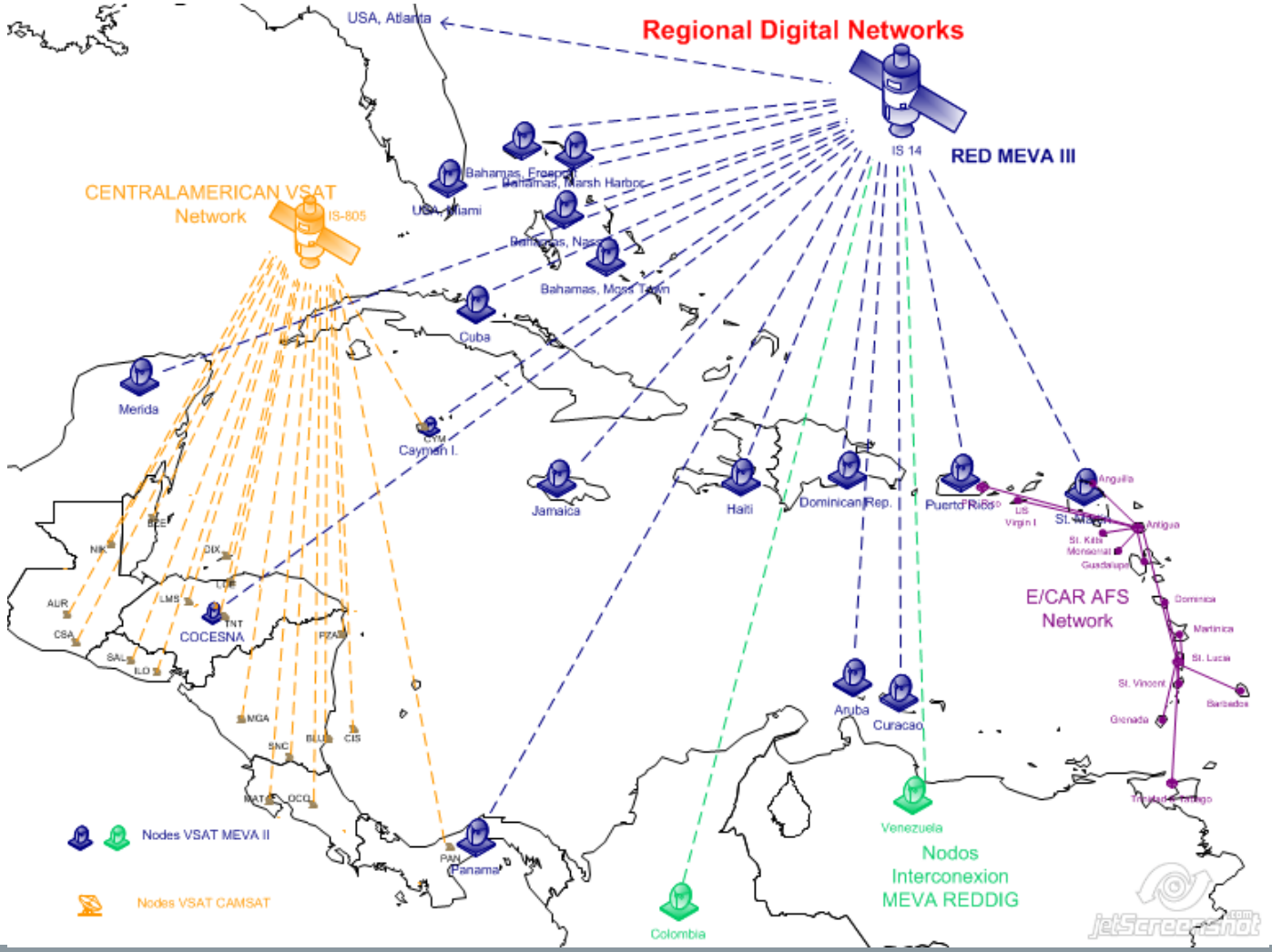
Mode S Radar implementation:

- ✓ 7 SSR Mode S Radar in Central America
- ✓ 1 SSR Mode S in Trinidad and Tobago
- ✓ Several SSRs in Mexico

ADS-B implementation :

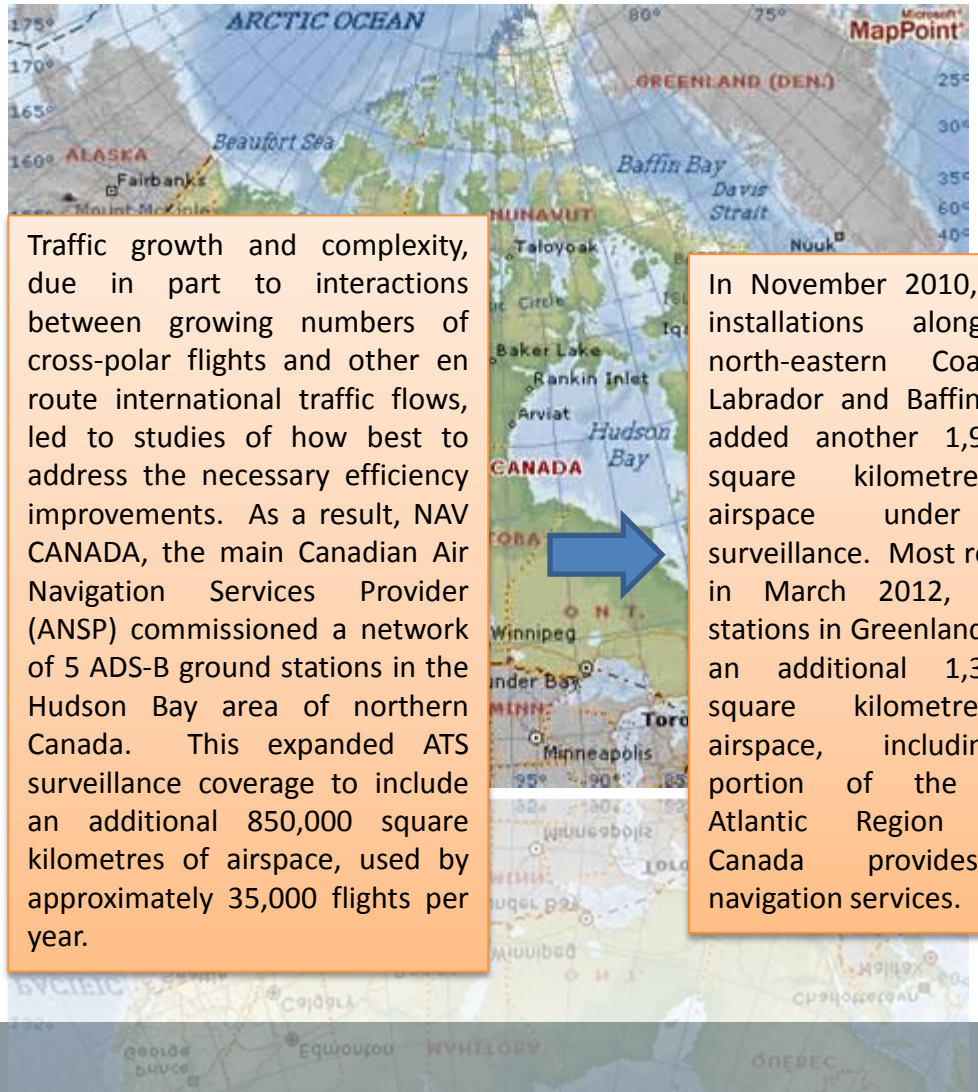
- ✓ Cuba
- ✓ Jamaica
- ✓ Trinidad and Tobago
- ✓ Mexico
- ✓ Central America

Implementation in the CAR/NAM Regions



Implementation in the CAR/NAM Regions

Prior to 2009, Canada relied upon primary and secondary radar systems to provide Air Traffic Services (ATS) surveillance services



Traffic growth and complexity, due in part to interactions between growing numbers of cross-polar flights and other en route international traffic flows, led to studies of how best to address the necessary efficiency improvements. As a result, NAV CANADA, the main Canadian Air Navigation Services Provider (ANSP) commissioned a network of 5 ADS-B ground stations in the Hudson Bay area of northern Canada. This expanded ATS surveillance coverage to include an additional 850,000 square kilometres of airspace, used by approximately 35,000 flights per year.

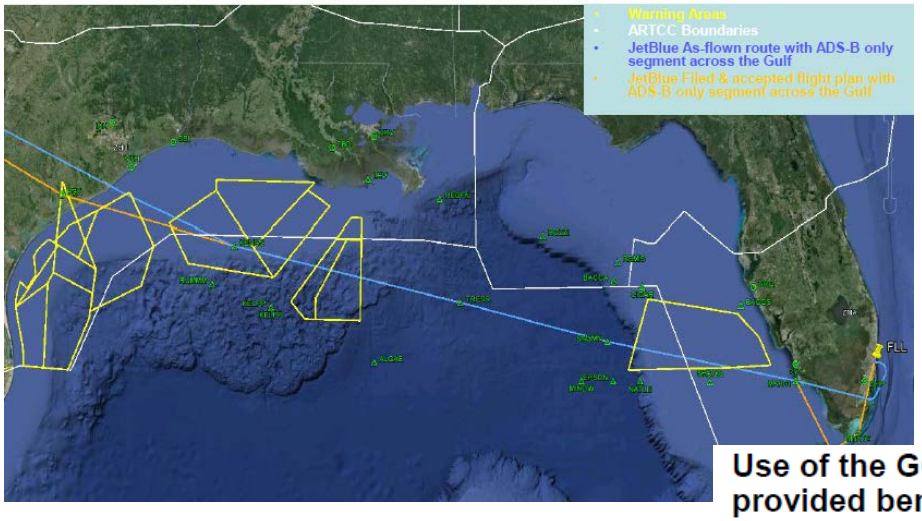
In November 2010, ADS-B installations along the north-eastern Coast of Labrador and Baffin Island added another 1,920,000 square kilometres of airspace under ATS surveillance. Most recently, in March 2012, ground stations in Greenland added an additional 1,320,000 square kilometres of airspace, including a portion of the North Atlantic Region where Canada provides air navigation services.

ADS-B implementations allow air traffic controllers to apply surveillance-based separation minima rather than procedural separation minima, which were on the order of 60 nautical miles (NM) laterally and 80 NM longitudinally. The fuel savings from the Hudson Bay implementation are estimated at 21 million litres annually, and those from the Labrador, Baffin Island and Greenland implementations are estimated at 9 million litres annually. These estimated fuel savings equate to avoided CO_2 emissions of 77,000 tonnes annually.

Implementation in the CAR/NAM Regions

GULF OF MEXICO AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST (ADS-B)

JetBlue Flight 101, FLL-LAX
Sched. Dep. 1900 EDT 9/27/2013



JetBlue Airways, KZHU, and Miami Air Route Traffic Control Centre (KZMA) participated in an Automatic Dependent Surveillance-Broadcast (ADS-B) route test in the GOMEX airspace from August 15, 2013 to October 15, 2013.

Favourable results that demonstrated an increase in efficiency and cost saving benefits to the user when alternative ADS-B routes were used during periods when weather impacted the GOMEX airspace

Use of the GOMEX ADS-B only alternative to the Q routes has provided benefit to JetBlue for weather avoidance & in select clear day cases due to winds

- 18% of the ADS-B flights conducted demonstrated weather/wind avoidance on the southern route versus competitors on the longer northern route
- Demonstrated advantage over northern weather avoidance when en route storms do not preclude their usage and when winds on the southern avoidance route are more favorable than the northern route
  - Westbound flights may not realize this benefit if MNATE continues to be required
- Indicates clear day advantage if winds are more favorable on the ADS-B route
  - Westbound flights not likely to realize this benefit if MNATE continues to be required
- JetBlue achieved their goal of developing and implementing effective business practices to conduct regular ADS-B Out operations
- Route segment utilization sufficient to assess all offered segments in the LOA
  - 76% of all segments used SNOMN-TRESR-KENGS

Questions?

Thank You