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NORTH AMERICAN, CENTRAL AMERICAN AND CARIBBEAN OFFICE
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Castries, Saint Lucia, 7-11 August 2006

Agenda Item 4: **Specific Air Navigation Activities and Developments**
4.5 Communications, Navigation and Surveillance (CNS)

FOLLOW-UP ON THE DEVELOPMENTS OF THE E/CAR CNS SYSTEMS

(Presented by the Secretariat)

SUMMARY

This working paper presents an analysis and proposals of the follow-up plan for the improvement and implementation of the Communications, Navigation and Surveillance systems and the radiofrequency spectrum protection in the Eastern Caribbean, based on the results of the review of the CNS conclusions of the E/CAR WG, E/CAR DCA, NACC/DCA, as well as the GREPECAS mechanism.

References:

- Report of E/CAR WG/29 Meeting
  (Saint Vincent and the Grenadines, 9 – 13 May 2005).
- Report of 19th E/CAR DCA Meeting
  (Barbados, 6 – 9 December 2004).
- Report of the NACC/DCA/2 Meeting
  (Tegucigalpa, Honduras, 11 – 14 October 2005).
- Report of the GREPECAS/13 Meeting
  (Santiago, Chile, 14 – 18 November 2005).

1. Introduction

1.1 The Twenty-Ninth Eastern Caribbean Working Group Meeting (29th E/CAR WG), held in Saint Vincent and the Grenadines, from 9 to 13 May 2005, with respect to the communications, navigation and surveillance agenda items of their work programme, carried out the follow-up of those tasks in accordance with the CNS guidelines agreed by the First Meeting of Directors of Civil Aviation of North America, Central America and the Caribbean, (NACC/DCA/1), held in Grand Cayman, October 2002, as well by the 19th E/CAR DCA Meeting, held in Barbados, 6 – 9 December 2004. Subsequent to the celebration of the 29th E/CAR WG Meeting, the NACC DCA/2 Meeting, held in Tegucigalpa, Honduras, from 11 to 14 October 2005; and the GREPECAS/13 Meeting, held in Santiago, Chile from 14 to 18 November 2005; both Meetings issued appropriate guidelines to the work of the Eastern Caribbean Working Group.

1.2 Regarding CNS matters, the 29th E/CAR WG Meeting, adopted the following Conclusions:

29TH E/CAR WG MEETING	
No.	**CONCLUSIONS ON CNS MATTERS**
29/4	*Improve connection between E/CAR Network and FAA AFTN and voice circuits*
29/5	*Notification of network failures and feedback procedures between the French Antilles and Trinidad and Tobago*
29/6	*Increase the reliability of the E/CAR digital network*
29/7	*The need of a contract with the provider TSTT*

1.3 Based on the Report of the Special E/CAR CNS Meeting, that was held in Port of Spain, Trinidad and Tobago, from 20 to 22 October 2004, the 19th E/CAR DCA Meeting formulated the following conclusions related to CNS matters:

19TH E/CAR DCA MEETING	
No.	**CONCLUSIONS ON CNS MATTERS**
19/8	*Upgrade of the E/CAR AFS Network on Frame Relay Management System*
19/9	*Improving the interconnection and interoperability of the E/CAR AFS Digital Network with Neighbouring Networks*
19/10	*Study the feasibility and update the strategy plan of modernization of the voice and data circuit between Port of Spain and San Juan*
19/11	*Proposal for Amendment to the ATS requirements for speech circuits communications in the Table CNS 1C, FASID*
19/12	*Updated E/CAR Surveillance Plan*
19/13	*Requested information on E/CAR radar coverage*
19/14	*Requested technical information on Radar Stations*
19/15	*Requested Letter of Agreement regarding the provision of radar data to the DACOTA System*
19/16	*Request for support of the E/CAR CNS activities*
19/17	*Follow up the progress of the possible radar remoting to Piarco ACC*
19/18	*Compliance with the GREPECAS SAC-ASTERIX Assignment Plan*
19/19	*Preliminary guidance on technical infrastructure as support to the evolutionary implementation of ATS/ATM automated systems*
19/20	*Transfer the task related to flight plan and position reports to E/CAR ATM Committee*
19/21	*Transfer the task related to oceanic surveillance to E/CAR Working Group*
19/22	*Provision of AMHS technology-related information*
19/23	*Provision of available information of Data Link Technology*
19/24	*E/CAR activities for GNSS Implementation*

1.4 The NACC/DCA/2 Meeting formulated the following conclusion, which is related to the purpose of this working paper:

NACC/DCA/2 MEETING	
No.	**CONCLUSION ON CNS MATTERS**
2/13	*Support of States in the NAM/CAR Regions to ICAO's position for the ITU WRC-2007*

1.5 Likewise, the GREPECAS/13 Meeting adopted the following conclusions, all of which are related to the issues dealt with this paper.

GREPECAS/13 MEETING	
No.	**CONCLUSIONS ON CNS MATTERS**
13/70	*Establishment of agreements to achieve the MEVA II – REDDIG Interconnection/Interoperation*
13/71	*Update and implementation of the VHF, HF and Satellite Voice Communication of the AMS and AMSS Plan*
13/72	*Regional strategy for updating evolutionary implementation of the air-ground data links plan*
13/75	*Request for information on plans to implement ATN ground-ground applications*
13/78	*Strategy and target dates for the deployment of ATN in the CAR/SAM Regions*
13/79	*Development of national plans to prioritize AMHS and AIDC implementation and contribute to ATM Automation*
13/81	*ICAO guidelines for the use of the public internet in support of aeronautical applications*
13/84	*Studies for a CAR/SAM Regional SBAS solution*
13/85	*Foster the use of GNSS in diverse sectors of the States*
13/87	*ADS-B trials programme in the CAR/SAM Regions*
13/88	*Proposal for Amendment to the Regional SAC ASTERIX Code Assignment Plan*
13/89	*Support of States in the CAR/SAM Regions to the ICAO position for the ITU WRC-2007*

2. Discussion

Communications

A) Ground-ground communication development

Improvement and Management of E/CAR AFS Digital Network

2.1 With regards to the improvement and management of the E/CAR AFS Digital Network, under IP/07 Trinidad and Tobago is informing the Meeting on the follow-up of the progress thus far by Trinidad and Tobago with regards to the resolution of identified deficiencies in AFS communication using the E/CAR AFS Digital Network.

2.2 Based on the presented information, the Meeting is invited to follow up Conclusions 29/5, 29/5 and 29/6 of the 29th E/CAR WG Meeting and Conclusion 19/8, of the 19th E/CAR DCA Meeting, and agree on the actions to give a proper follow up to the E/CAR management and improvement Plan.

Development and interconnection of regional/subregional digital network

2.3 The Meeting should follow up on the status of implementation of the Trinidad REDDIG VSAT and the actions in order to achieve the interconnection and interoperability of the E/CAR AFS Digital Networks with neighbouring networks, such as MEVA II and REDDIG networks, that will facilitate the implementation of voice and data circuits over the network and contributing to the interconnection with other regional networks, creating a regional CAR/SAM digital platform with an open architecture facilitating the implementation of ATN and its applications.

2.4 As a follow-up to GREPECAS Conclusion 13/70, the NACC and SAM Regional Offices convened the Third MEVA II - REDDIG Coordination Meeting held in Mexico City, from 26 to 28 July 2006, with the intention of reaching agreements for the MEVA II – REDDIG interconnection/interoperability.

Improvement of the AFS circuits

2.5 Based on the information presented by Trinidad and Tobago under IP/06 and following up on Conclusions 29/4 and 29/5 of the E/CAR WG, the Meeting should follow up on the actions to improve the AFS communications in the Eastern Caribbean.

Implementation of the ATN ground portion

2.6 The GREPECAS/13 Meeting approved the initial works to review the ATN plan carried out by the CNS Committee. As part of this work, GREPECAS approved Conclusion 13/75 - *Request for information on Plans to Implement ATN ground-ground applications*, through which a request was made to the States/Territories/International Organizations to provide detailed information on the requirements and plans to implement the ATN ground-ground applications, such as AMHS and AIDC based in the Table contained in Appendix AZ of the GREPECAS/13 Meeting Report. This table is presented in **Appendix A** to this paper.

2.7 The Meeting also should consider that GREPECAS Conclusion 13/78 encouraged States/Territories/International Organizations to initiate activities for ATN deployment and its applications according to the target dates and strategy presented in Appendix BA of its Report. The mentioned Appendix is shown in **Appendix B** to this paper. Additionally, GREPECAS/13, through its Conclusion 13/78, issued initial guidelines for the development of AMHS and AIDC implementation national plans.

2.8 The Secretariat considers appropriate that this Eastern Caribbean Working Group Meeting begins the execution of the work corresponding to the Group's area guided by the GREPECAS, as referred in the previous paragraphs.

B) Development of air-ground communications

Review of the status of the VHF and HF voice communications implementation

2.9 The members of the Group are expected to provide information to the Meeting on their respective Administration's plans to improve and complete the VHF/AMS communications coverage. Moreover, based in the status of the coverage, the Meeting could establish actions related to this work.

2.10 With respect to HF communication, based on IP/05 presented to this Meeting by Trinidad and Tobago, the E/CAR Working Group should continue the follow-up of the implementations of permanent solutions to the Piarco HF communication deficiency.

Implementation of the air-ground data links

2.11 Based on the relevant conclusions adopted, the Meeting should follow up the action plans in order to implement VHF, HF and satellite data links in the Eastern Caribbean.

2.12 The GREPECAS/13 Meeting in its Conclusion 13/72 - *Regional Strategy for updating evolutionary implementation of the Air-Ground Data Links Plan,* guided the States/Territories/International Organizations to carry out its activities aimed at the air-ground data links deployment based in the regional Strategy for updating and executing the air-ground data links plan, developed by the activities Plan and the Implementation programme presented in Appendices AW and AX respectively of its Report; and that based on the regional Strategy mentioned, review and propose updates to the corresponding part of the implementation of air-ground data links of the CAR/SAM Regions contained in Table CNS 2A of the FASID; likewise, to inform on the results of these actions to the ICAO Regional Office **before 30 may 2006**. The respective Appendices AW and AX of the GREPECAS/13 Meeting Report are shown in **Appendix C** and **Appendix D** to this working paper.

2.13 Considering the abovementioned , the Eastern Caribbean Working Group Meeting should follow up the action plans in order to implement VHF, HF and satellite data links in the Eastern Caribbean.

Regional use of public Internet for aeronautical applications

2.14 Through its Conclusion 13/81, GREPECAS recommended CAR/SAM States/Territories/International Organizations to consider the use of the public Internet in support of the aeronautical applications, and by doing so, to take into account and apply the *"Guidelines for the Use of the Public Internet for Aeronautical Applications"* contained in the ICAO Manual, Ref.: Doc 9855. This Meeting should take note of this conclusion and direct measures to apply these guidelines in the Administrations of this Group's members.

Navigation

2.15 The Meeting should follow up the status of improvement of conventional radio navigation aids. IP/03 and IP/04 presented by Trinidad and Tobago provide information on this matter.

2.16 The Meeting should consider that in respect to the studies carried out by the RLA/00/009 and RLA/03/902 projects for a CAR/SAM regional SBAS solution, the GREPECAS/13 Meeting noted that it is technically and operationally impractical to extend the coverage of the wide area augmentation system (WAAS) and EGNOS system to the CAR/SAM Regions. Therefore, Conclusion 13/84 was formulated – *Studies for a CAR/SAM Regional SBAS solution,* which, among other aspects, encourages States/Territories/International Organizations to "*continue the GNSS introduction in a evolutionary and coordinated manner, according to the ICAO Global Plan, conducting studies for a regional SBAS solution consistent with the requirements and characteristics of the CAR/SAM Region; and applying other applications, also taking into account that added benefits should help to justify the cost of reaching the ultimate goal of migrating to the GNSS, once ground-based aids are dismantled"*.

2.17 Additionally, based on Conclusion 13/85 of GREPECAS – *Foster the use of GNSS in diverse sectors of the States*, the E/CAR WG Members should note this conclusion and recommend actions to their Administrations aimed at taking advantage of the GNSS benefits in diverse sectors of States and disseminate the results being obtained on the SBAS studies solution.

2.18 According to the navigation systems introduction and evolutionary strategy which is being considered by ICAO to be incorporated as part of the second amendment to the Global Air Navigation Plan for CNS/ATM Systems (Doc. 9750-AN/963) and will be circulated shortly to States/Territories/International Organizations, airspace users need a globally interoperable navigation infrastructure that provides benefits in safety, efficiency and capacity. Aircraft navigation should be straight-forward and conducted to the highest level of accuracy supported by the infrastructure. To meet those needs, the progressive introduction of performance-based navigation must be supported by an appropriate navigation infrastructure consisting of an appropriate combination of global navigation satellite systems (GNSS), self-contained navigation systems (inertial navigation system) and conventional ground-based navigation aids.

2.19 GNSS-centered performance-based navigation enables a seamless, harmonized and cost effective navigation service from departure to final approach that will provide benefits in safety, efficiency and capacity.

2.20 GNSS implementation will be carried out in an evolutionary manner, allowing gradual system improvements to be introduced. Near-term applications of GNSS are intended to enable the early introduction of satellite-based area navigation without any infrastructure investment, using the core satellite constellations and integrated multisensor airborne systems. The use of these systems already allows for increased reliability of non-precision approach operations at some airports.

2.21 Medium/longer term applications will make use of existing and future satellite navigation systems with some type of augmentation, or combination of augmentations required for operation in a particular phase of flight.

2.22 Considering the latest conclusions of GREPECAS and the revised Global Air Navigation Plan for CNS/ATM Systems strategy, the Meeting should issue action proposals for the early introduction of GNSS applications in the short-term allowing the early introduction of satellite-based area navigation (RNAV) without any infrastructure investment, using basic-satellite constellations and the integrated multi-sensors systems, non-precision approach (NPA) and required navigation performance (RNP) procedures. Also, the Meeting should recommend actions to follow-up the GNSS evolutionary development for the introduction of a planned medium/longer term application.

<u>Surveillance</u>

Surveillance plan

2.23 Although that the GREPECAS/12 Meeting through its Conclusion 12/50 updated Table CNS 4A of the FASID – *FASID Surveillance Plan* with the information available at the time of the celebration of their meeting, it is considered that the members of the Eastern Caribbean Working Group who participated in that Meeting, could provide new information to update the corresponding Eastern Caribbean Surveillance Regional Plan, especially on Primary Surveillance Radar (PSR), Secondary Surveillance Radar (SSR) and Automatic Dependent Surveillance (ADS). The E/CAR WG Meeting should follow up on the status of implementation and developments of surveillance systems in the Eastern Caribbean.

Radar data sharing

2.24 It is expected that the Meeting will follow up the work carried out by the Radar Data Sharing Task Force, following the tasks for the establishment of the radar data exchange in the Eastern Caribbean.

Studies on the Implementation of secondary surveillance radar in Mode S

2.25 The GREPECAS/13 Meeting received information on the overview on the secondary surveillance radar (SSR) system in Mode S presented in Appendix BE to the GREPECAS/13 Report on Agenda Item 3 and considered that to implement the SSR in Mode S, it is essential to study and consider the areas in which the installation of this type of radar might be justified. The Meeting also considered that the implementation of Mode S in these regions are favoured by the fact that numerous SSR installed are monopulse technique and generally have the capacity of allowing Mode S. Moreover, the Meeting noted that Brazil, Colombia, Mexico and the Dominican Republic have installed SSR in Mode S. Information on the overview development of SSR in Mode S is presented in **Appendix E** to this working paper.

Studies on the regional implementation of ADS-C and ADS-B systems

2.26 The GREPECAS/13 Meeting, recalled that the AN-Conf/11 Recommendations 1/6 and 1/7, approved the use of automatic dependent surveillance-broadcast (ADS-B) system to support the global ATM system and to contribute to the achievement of global interoperability, taking into account the Recommendations of the AN-Conf/11, the Global Air Navigation Plan for CNS/ATM systems (Doc 9750) and the industry developments.

2.27 The GREPECAS/12 Meeting, through Conclusion 12/44 guided the application of Mode S extended squitter (1090 ES), as the initial data link to implement the ADS-B.

2.28 The E/CAR WG should study the possibility and need to implement the ADS Contract system (ADS-C) and/or ADS-B in the Eastern Caribbean, considering the overview development and the SARPs status and the ATM need of these systems. **Appendix F** to this paper contains information on the overview of ADS-C and ADS-B systems development.

Other matters related with the implementation of CNS systems

2.29 Additionally, the E/CAR Working Group may follow up on the coordination and implementation of other matters related with the CNS systems foreseen in the Regional CAR/SAM Air Navigation Plan and the Regional Plan for the Implementation of the CNS/ATM Systems, taking into account the guidance of GREPECAS.

3. Suggested actions

3.1 The Meeting is invited to:

a) take note of the contents of this working paper;
b) follow-up the Communications systems development, considering paragraphs 2.1 to 2.13;
c) direct actions to apply the ICAO guidelines in the use of the public Internet for aeronautical applications; bearing in mind the guidelines referenced in paragraph 2.14 to this paper;
d) follow-up the Navigation systems improvement and evolutionary development, considering paragraphs 2.15 to 2.22, the GREPECAS guidelines and the new ICAO SARPs;
e) follow-up the Surveillance systems development, considering paragraphs 2.23 and 2.28 of this paper; and
f) review other issues that the meeting considers pertinent.

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APPENDIX A

Table CNS-1Bb – ATN GROUND-GROUND APPLICATION PLAN

EXPLANATION OF THE TABLE

Column

1 Administration – the name of the State, Territory or International Organization responsible for management of an ATN ground-ground application facility and Location.

2 Facility Type – Facility Type of ATN ground-ground application managed by Administration indicated in column 1.

AMHS – ATS Message Handling System.
AIDC – ATS Inter-facility Data Communication.

3 Name of the Administration and Location of the correspondent ATN ground-ground application facility connected with facility indicated in columns 1 and 2.

4 Standard used in the facility indicated in columns 2.

5 Date of implementation of the facility.

TBD – To be determined.

6 Remarks.

APPENDIX/APÉNDICE A
(Appendix AZ to the Report on Agenda Item 3 of GREPECAS/13)
(Apéndice AZ de la Cuestión 3 del Informe GREPECAS/13)

Table CNS 1Bb – ATN GROUND-GROUND APPLICATIONS PLAN / Tabla CNS1 Bb – PLAN DE APLICACIONES TIERRA-TIERRA ATN

ATN GROUND-GROUND APPLICATIONS PLAN / PLAN DE APLICACIONES TIERRA-TIERRA					
Administration and Location/ Administración y localidad	Application Type/ Tipo de Aplicación	Conneted with Administration & Location of/ Conectada con Administración y Localidad de	Used Standard / Norma usada	Implementation Date/ Fecha de Implementación	Remarks/ Observaciones
1	2	3	4	5	6

APPENDIX B
(Appendix BA to the Report on Agenda Item 3 of GREPECAS/13)

	CAR/SAM Regional Strategy for the deployment of the ATN and its applications
	Short term (2005 – 2011)
1.	States/Territories/International Organizations complete the updating of the aeronautical digital communication networks by providing intra and inter-regional interconnection and interoperability.
2.	The ATN ground-to-ground portion will initially support the implementation of the ATS message handling system (AMHS) to replace the AFTN.
3.	States/Territories/International Organizations carry out the strategic deployment of a limited number of ATN routers of the ATN backbone to support other ground-ground and air-ground applications.
4.	During the transition phase some AFTN circuits and systems may remain in operation. A reasonable timeframe must be established for its replacement with AMHS.
5.	The referred ATN routers must provide AFTN/AMHS gateway during the transition phase.
6.	States/Territories/International Organizations carry out the gradual updating of the AFTN centres by AMHS servers. In order that necessary interfaces in the AFTN centres be implemented to connect AMHS circuits and the new AMHS servers be implemented with the capacity of connecting AFTN circuits.
7.	The implementation of the AIDC within control centres of adjacent States/Territories/International Organizations begins.
8.	States/Territories/International Organizations must work in close cooperation to support themselves on a multinational basis to implement the ATN and its applications to ensure the system interoperability.
9.	States/Territories/International Organizations must undertake the training of operational and technical personnel in order to provide the necessary knowledge to introduce the ATN and its ground-ground applications (AMHS and AIDC).
10.	Based on the relevant deployment of the ATN ground-to-ground infrastructures and ground applications, States/Territories/International Organizations must gradually introduce ATN air-ground applications.
11.	Implementation will be in full agreement with SARPs, ICAO PANS and GREPECAS guide.
	Medium term (2011 – 2015)
12.	Here the implementation of AMHS must be completed and the implementation of the AIDC continues.
13.	States/Territories/International Organizations must extend the deployment of air-ground applications.
14.	The use of the ATN with techniques defined in the SARPs continues and the planning to update the ATN terrestrial portion commence to satisfy the new ATM global system requirements.
	Long term (As of 2015)
15.	Planning and implementation of the ATN and its applications will be carried out in accordance with the ATN evolution and the development of associated techniques and in conformity with the ATM global system requirements and the new SARPs, ICAO PANS and GREPECAS guidelines.

APPENDIX C
(Appendix AW to the Report on Agenda Item 3 of GREPECAS/13)

CAR/SAM REGIONAL ACTIVITIES PLAN FOR A PLANNING AND IMPLEMENTATION OF AIR – GROUND DATA LINKS

1. Participate in seminars and workshops on air – ground data links.

2. Review and update the Regional Plan of air – ground data links (Table CNS 2A) to achieve benefit of data communications improving safety, efficiency and capacity through the reduction of voice communications and implementing as an evolutionary way the automatic process to meet the operational requirement and coordinated and harmonized with the global ATM system.

3. Evaluate the capacity and the need to modernize the control centres and the aircraft fleet operating in the respective FIR and airspace in order to implement the air – ground data links in accordance with the operational requirements, the SARPs and the ICAO guidance, incorporating the implementation planning of the mentioned capacity.

4. Establish and participate in a programme of trials and demonstrations on systems and applications of air – ground data links.

5. Examine and evaluate the arrangements made by other States/international Organizations for the implementation of data links, establishing cooperation mechanisms on a multinational basis.

6. In accordance with the global Road Map, establish a CAR/SAM regional programme for the evolutionary implementation of air – ground data links ensuring the regional and inter-regional interoperability to satisfy the global ATM system requirements in a coordinated, harmonized and seamless way.

7. Undertake and monitor research and development of communication technology and follow the development of SARPs and ICAO guidance for future evolution of data link services.

8. These activities should be developed for execution of the implementation program that is shown in Appendix AX.

APPENDIX D
(Appendix AX to the Agenda Item 3 of the Report of GREPECAS/13)

CAR/SAM REGIONAL PROGRAM FOR THE IMPLEMENTATION OF THE AIR – GROUND DATA LINKS *		
TERM	**GOALS IN THE IMPLEMENTATION OF INFRASTRUCTURE**	**SERVICES**
Near Term (2005–2009)	To implement ACARS, FANS, VDL-Mode 2 and HFDL based on SARPs and ICAO guidance.	Make maximum use of: - pre-departure dispatch; - oceanic dispatch; - D-ATIS; - other flight and routine information messages; and - automatic position reporting on the part of the operating aircrafts.
Medium Term (2009–2014)		- more complex safety related information can be exchanged, including ATC clearances.
Long Term (after 2014)	Implement Data links as the future evolution and based on the new SARPs and ICAO guidance.	- The use will include down linking of aircraft flight parameters for use by the ATM system; and - uplink of traffic data for improved situational awareness in the cockpit.

Note:
***** This regional Program is in accordance with the global Road Map for the implementation of air – ground data links.

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APPENDIX E

OVERVIEW ON THE SECONDARY SURVEILLANCE RADAR SYSTEM IN MODE S

Generals

1. SSR is used either as autonomous system or in common movement and synchronised with the primary radar of surveillance (PSR). The ground equipment is an interrogator and the aircraft equipment is a transponder responding to the signals issued by the interrogator. All SSR facilities operate in 1,030 MHz for the air-ground interrogation signal and in 1,090 MHz for the air-ground response. The wide utilisation of the repetitive pulse frequency (RPF) discrimination and the techniques for treatment of the radar points plan, help to reduce the number of invalid responses processing the ground-reception system.

2. SSR employs Mode A to transmit the identification and Mode C to transmit the altitude precision information. Mode S uses the aircraft selective routing and its capacity of data link is limited. Mode S has been established as a permanent need, especially in some high-density air traffic airspace parts.

Mode-S Secondary Surveillance Radar System

3. The Mode-S Secondary Surveillance radar system is a new radar generation that shall replace the current SSR. The general principle of the SSR is to interrogate transponders on board of aircraft, which, as per the interrogation received respond to the aircraft identification (Mode A) or its flight level (Mode C).

4. The current identification methods of SSR have reached its limit, it is always more difficult to assign a unique code Mode A to an individual flight, creating high risk in lack of identification.

5. Mode S radars overcome these difficulties identifying all aircraft individually on a global basis. Hence, their name “S” (selective). Thus, Mode S is based in the selective routing concept in which each aircraft is identified by a single ICAO Code composed of 24 bits; it represents the routing of the aircraft.

6. The selective function of these radars ensures the data integrity and increases the probability of detection. The Mode S radar operates in the same frequency of conventional SSR radars (1030 MHz for ascending link and 1090 MHz for descending link) and is compatible with SSR Mode A and C.

7. Also, the Airborne Collision Avoidance System (ACAS II) uses the Mode S transponder when both systems are connected.

8. ICAO SARPs related with Mode S are contained in Annex 10, Volume III, Chapter 5 (SSR Mode S air-ground link), Chapter 9 (Plan of aircraft directions), Annex 10 Volume IV, Chapters 2 and 3, and Document 9684 (Manual on secondary surveillance radar (SSR), as well as Document 9688 (Manual in Mode S – specific services).

APPENDIX F

OUTLOOK ON THE ADS-C AND ADS-B SYSTEMS DEVELOPMENT

References:

- Global Air Navigation Plan for CNS/ATM systems – Second Edition -– 2002. (Doc 9750 – AN/963).
- Report of the AN-Conf/11. Montreal, 22 Set. – 3 Oct. 2003.
- Annex 10, Volumes III and IV.
- Annex 11 y Doc 4444.
- Data links applications for the air traffic services (Doc 9694).

1. *ADS SYSTEM*

1.1 The automatic dependent surveillance (ADS) is an application for the ATS use in which the aircrafts transmit to the ATC automatically, through the air-ground data communications, information, sufficiently accurate and reliable, derived from the airborne navigations systems. As a minimum those data include the aircraft identification and in three-dimensional position, but additional data may be provided as appropriate. The ATC system would use the ADS data to present information to the controller and it must also have the capacity to exchange messages between the pilot and the controller, through data and voice links, in order to perform emergency and non-routine communications.

1.2 The ADS may provide surveillance services in the following areas:

a) where the current infrastructure lacks of radar surveillance services in particular the oceanic areas and other in which the conventional systems are difficult, very expensive or impossible to implement;
b) in high density air traffic areas where it may serve as an adjunct and/or back-up for the secondary surveillance radar (SSR) thereby reducing the need for primary surveillance radar (PSR); and
c) in some circumstances, it may substitute the secondary radar.

2. *ADS-B SYSTEM*

2.1 The automatic dependent surveillance-broadcast (ADS-B) is an application of the ADS technique defined by ICAO as a surveillance technique which an aircraft periodically and automatically broadcasts, through data links in a broadcast mode, derived data of the airborne navigation systems and its four-dimensional position, including the aircraft identification and additional information when required. The broadcast signals could be received and processed by the aircrafts and ATM units under the coverage of those signals. Nowadays, the ADS-B is defined only for line-of-sight operations (e.g. broadcast over VHF digital link or by SSR Mode S extended squitter).

2.2 ADS-B facilitates ATM automation, as a subsystem of the future ATN, given its component of inter-operability that ensures interconnectivity with radar systems and other communication subsystems by data link communications at a national, regional and global scale.

2.3 Tests carried out in other ICAO regions of the world on the performance of the ADS-B system have superseded the expectations with operational applications in diverse scenarios for all flight phases, an excellent coverage and updated information rate superior than the performance level expected from a secondary radar installed in the same site, the human performance is better than with the radar and the identity data is received reliably.

2.4 The ADS-B goes beyond the traditional surveillance service, since it takes into account the heterogeneous and evolutionary situation of the available ground infrastructure, extending its capability in air-air, air-ground and ground-ground applications through the interaction among the airborne and ground elements and ATM automated systems; as well as the performance of the human element for the collaborative decision-making process.

2.5 The surveillance levels attained by the ADS-B are the elementary surveillance, the perfected surveillance (using the status vector), the objective-based surveillance (using the envisaged path) in terrain and on the air, as applicable, providing additional data such as the status vector and the envisaged path of "gate-to-gate" operations, which is to say, airport surveillance. Likewise, the ADS-B allows to increase the capacity of the future ATM system and to improve the safety levels.

Scenarios of the global ATM defined to obtained improvements by ADS-B

2.6 The Global Air Navigation Plan for CNS/ATM systems defined that improvements could be obtained through ADS and ADS-B functions in the following type of spaces:

- oceanic/continental en-route airspace with low density traffic;
- oceanic airspace with high-density traffic;
- continental airspace with high-density traffic;
- terminal area with high-density traffic; and
- terminal area with low-density traffic.

ADS-B Application

2.7 The AN-Conf/11 identified an initial set of operational applications of air-ground and air-air surveillance through the ADS-B, suitable for the high density traffic areas, without excluding other areas, and among these applications are the following:

<u>ADS-B main applications for ATC surveillance:</u>

2.8 If aircrafts are well equipped, ADS-B could be used to:

a) to complete the coverage of SSR (to cover areas without secondary radar coverage);
b) replace the SSR service in areas with low and medium traffic density;
c) en-route airspace;
d) terminal areas;
e) as the basis for a air traffic presentation of the piloting position (CDTI); and
f) for the surface movement, therefore becoming an alternative for the surface radar such as the airport surface detection equipment (ASDE) and the Advanced Surface Movement Guidance and Control System (A-SMGCS).

ADS-B main applications for airborne surveillance:

a) enhanced traffic situational awareness on the airport surface;
b) enhanced traffic situational awareness during flight operations;
c) enhanced visual acquisition for see and avoid;
d) enhanced successive visual approaches;
e) enhanced sequencing and merging operations;
f) in-trail procedure in oceanic airspace; and
g) enhanced crossing and passing operations.

ADS-B Technology

2.9 The Eleventh Air Navigation Conference (AN-Conf/11), by Recommendations 1/6 and 1/7 approved the use of the concept of ADS-B as an enabler of the global ATM operational concept contributing to achieve the global interoperability. Likewise, based in Recommendation 7/1 of the An-Conf/11, GREPECAS, through its Conclusion 12/44 guided to the initial use of data links SSR Mode S extended squitter for the ADS-B implementation in the CAR/SAM Regions.

2.10 The surveillance systems established have limitations that could not satisfy the capacity, flexibility and efficiency needs which are required to fulfil the air traffic growth in the future. To overcome these limitations the aeronautical industry has developed various surveillance technologies including the data links SSR Mode S 1090 MHz extended squitter (1090 ES) as a mean of interoperability for ADS-broadcast in a short term. The 1090 ES system can support an air-ground coverage up to more than 200 NM to provide ATC surveillance, depending on the configuration and location of the ground stations. Also, air-air coverage of more than 100 NM depending on the avionics configuration used and the air traffic density involved.

2.11 Other technologies are being studied as candidates for the ADS-B data links, among them are the VDL in Mode 4 and the universal access transceiver (UAT).

Avionics

2.12 Boeing and Airbus are installing the ADS-B 1090ES capacity diffusion in their new aircrafts. Also, various ACAS installations could be ready to be updated for 1090ES transmissions. These avionic technologies for ADS-B data links are already in the market and are being successfully use, this has encouraged the users to its equipment installation.

Essential technical requirements for ADS and ADS-B

2.13 The essential technical requirements for the ADS-C and the ADS-B implementation systems are the following:

Technical requirements for the implementation of the ADS-C and ADS-B in the short term			
No.	Technical requirement	**ADS-C**	**ADS-B**
1	Position data supplied by the airborne navigational equipment.	✓	✓
2	Message time stamp within one second coordinated universal time (UTC).	✓	✓
3	VHF data communication links by air-ground or bi-directional satellite.	✓	
4	Unidirectional data links by spontaneous extended squitter of the SSR in Mode S.		✓
5	A ground infrastructure that provides ATC information.	✓	✓

Benefits

2.14 The ADS-B provides important benefits in view of its support capabilities to air navigation through the ground-based stations system to increase coverage or by a digital communications network such as controller-pilot data link communications (CPDLC) and of meteorological data to support the provision of ATC and FIS in the lower and upper airspace, and SAR in the lower airspace. Moreover, it facilitates the application of other capabilities such as traffic synchronization and conflict management to comply with new ATM operational requirements.

2.15 For conflict management, the ADS-B uses air-ground data link communications that support other automatic components for ATC surveillance such as short-term conflict alert, offset advisories to an assigned route and altitude and violation to special use airspace advisories, which will undoubtedly improve ATS safety.

2.16 Moreover, for the application of the interphase for the ADS-B provides potential benefits significantly reduces the workload of ATC controllers, as well as the negative impact of human resources, and it increases the precision of data which also results in the increase of safety.

2.17 For the future environment, the ADS-B provides potential benefits to the ATM community with new key operational applications in a more advanced and global ATM environment and it offers to widen its coverage to other mixed surveillance capabilities for crew as well as for air traffic services.

Cost of the ADS-B system implementation

2.18 The ADS-B system implementation is a very useful surveillance option and some pioneering States determined its lower cost than the secondary surveillance radar.

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