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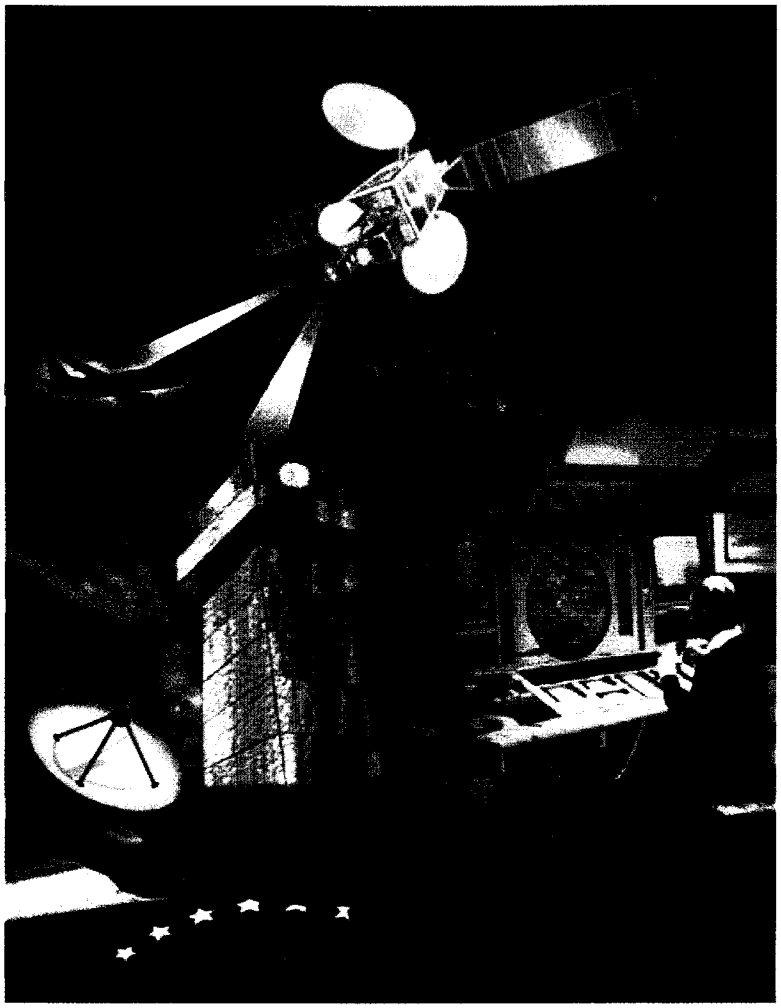

FEASIBILITY STUDY FOR THE CNS/ATM TRANSITION PLAN IN VENEZUELA

Final Report and Transition Plan

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Introduction

Venezuela's aviation system is a critical point. For decades, the system has been largely neglected, as national infrastructure investments were directed to other sectors and industries. By consequence, a system that had once been a leader in South American aviation safety has weakened, as systems have aged far beyond operational life cycles.

Venezuela's current architecture is characterized by a vast quantity of outdated equipment. Aged systems cannot be relied on to provide effective service—they are subject to critical failures and, once malfunctioning, replacement parts cannot be obtained, because they are no longer manufactured. The only means for getting repairs in these circumstances is by cannibalizing other systems for parts—a practice that is ill-advised and illegal policy in Venezuela. Consequently, if the nation intends to maintain a bare level of aviation functionality, it must look to bringing about major system purchases soon.

Civil aviation depends on the availability of a secure, safe support system. Our team devoted itself to examining the prospects for helping Venezuela attain this goal. This was executed in seven interrelated activities:

- Understanding the operational needs that are driving the national modernization efforts,
- Evaluating Venezuela's current infrastructure capabilities through statistical review and site visits,
- Determining the regional and international airspace and infrastructure requirements that apply to Venezuela,
- Developing options for modernization that suit Venezuela's requirements
- Developing a financial analysis to identify the most cost-effective modernization approach, and
- Assessing prospects for project financing

Our team executed these activities over the course of close to three years. Conclusions and findings for these efforts have been submitted in five technical task reports. This final report summarizes conclusions and provides a transition plan for accomplishing the plan that meets national and international technical requirements for the lowest cost.

CNS/ATM will enhance the operational capability of the airspace system, although different implementation options will bring different benefits. ICAO has developed guidelines for analyzing the overall CNS/ATM implementation requirement. This, however, must be correctly interpreted and suitably modified to evaluate the costs and benefits of a satellite navigation system in a comparative framework.

Although the current situation Venezuela faces is serious, we conclude that the situation does look more favorable than did at the start of the project. The creation of the Instituto Nacional de Aviation Civil (INAC) promises to provide a mechanism for greater institutional autonomy. With autonomy, comes a new capability to redefine the future of Venezuela's aviation system.

Moreover, our findings demonstrate that modernizing will not only provide Venezuela with a safe aviation system, it will make INAC more profitable as an organization that it would be if no action is taken.

Analysis of Venezuela's Systems

Over the year 2002, Innovative Solutions International provided a comprehensive review of Venezuela's civil aviation infrastructure. The effort included site visits and data monitoring over the course of 2002.

Operational systems are failing at dangerously increasing levels; despite the considerable efforts engineering staff sustain to maintain systems. Prospects for sustaining the current system are dismal: many systems are so out-of-date that replacement parts are no longer available.

Most technical systems are aging well beyond their effective lifecycles. Some systems are so old, the only means of repairing a particular installation is to cannibalize another. Consequently, many systems are beyond the frequently inventive repair measures offered by maintenance staff. The result is that failures and partial failures exist at unacceptable levels.

The overall CNS/ATM system is characterized by an aging infrastructure and a short supply of spare parts. The technologies that exist today, reflects a system that maintained currency up until about twenty years ago—although recent efforts, like the purchase of new ILSs demonstrate a new national dedication to improvement. In many cases, equipment is installed for which replacement parts are no longer available. In these circumstances, the only feasible way to keep systems running is to cannibalize other installations.

The ground-to-ground telecommunications system is also in poor condition at many sites. Airports have resorted to a variety of means to accommodate this deficiency. This causes problems both for local operations—like repairs—where communications are necessary with the tower—and for necessary communications between airports.

Site visits also showed that none of the airports had a cohesive operations and maintenance plan or management. Strategically, systems would benefit from a coherent effort to coordinate management at the local level. Master planning—including triage, work effort prioritization and integrated maintenance activity scheduling—could help better ensure that existing systems are sustained longer. This kind of work is performed well at the higher organizational levels of INAC; however, similar efforts need to be performed in a coherent way at the local level.

Overall, the prospects of any management effort will be greatly enhanced by the development of better statistics. Costs could be rationalized for the effort of setting up a system to automatically track statistics on operational and maintenance activities, including mean-time-to-repair, mean-time-between-failures, movements and delays. Better statistics will enable management staff to justify expenses, track costs and realize income in a more productive manner.

Related to the problems noted, staff morale needs strengthening. Civilian staff needs career paths. Pension problems need correction, new staff is needed—especially controllers–and recurrent training is needed. But despite problems, our team recognizes the considerable dedication and ingenuity INAC technical and operational staff bring to their jobs: without this, the aviation system would be much worse.

Finally, it must be noted that, facilities are frequently in bad condition, particularly in air traffic control towers. Many structures are badly deteriorated, bathrooms don't operate, staff resort to obstructing windows to shade out the sun and heating and cooling systems do not operate consistently. The study team is aware that responsibility for these arrangements falls on airports, they are mentioned here as important concerns for INAC, since such poor conditions not only can be dangerous, they also work to erode the morale of INAC control staff.

This was confirmed recently by two other assessments. In 2002, the FAA dropped its approval of Venezuela's airworthiness. ICAO also delivered an assessment that found the system to be functioning at unacceptable levels.

Moreover, much of the civil aviation staff is aging and the administration faces a difficult retirement crisis. Those on the job suffer bad work conditions and are stretched thin to fill extra responsibilities. At the same time, the failing systems prevent controllers from doing the jobs they are trained to do. For instance, there were three mid-air collisions in the year that were prevented by Airborne Collision Avoidance Systems in the aircraft—not by air traffic control.

Presently, Venezuela finds itself at a critical status. The new organizational structure, National Institute of Civil Aeronautics (INAC) faces a large challenge to reverse the spiral of deterioration noted in this report.

To remedy this situation, our team suggests that INAC immediately initiate a strategic planning process. Old equipment must be replaced in the most efficient manner possible, while sustaining the few structures in place that are making Venezuela's civil aviation system function despite numerous breakdowns. Systems must be modernized and integrated to bring the airspace in line with GREPECAS regional standards. New systems must be matched to long-term engineering sustainability requirements. This means that spare parts and training must be planned and budgeted over the entire life cycle of the system. At the same time, INAC has a mandate from its labor force to remedy the unfulfilled policies and bad conditions that characterize their current work environment.

Methodology

The started with a data collection process. Questionnaires were used to obtain large data requirements; site inspections verified and refined site data; and interviews were conducted with worker and management (typically, air traffic controllers, technicians and managers) to obtain site-specific opinions and perspectives; and data supplied by INAC management. Finally, all collected data was evaluated, consistent with the requirements identified above.

Relevant information was extracted from a comprehensive questionnaire INAC personnel were requested to complete at Study initiation (Appendix A) and statistical operational information provided by INAC staff. This information, combined with the site survey data, provided a solid foundation for completing the work objectives. Additional statistical information was received throughout the study period, which was used to determine trends.

Site Surveys were conducted in accordance with standardized formats and procedures to document the findings and assure reporting consistency. To be able to construct a comprehensive analysis of existing conditions and estimate the future capabilities and limitations of the current systems, site-specific facilities, equipment, and photographic data were collected and documented. In addition, several on-site personnel were interviewed to determine their perspective regarding current and future CNS/ATM systems capabilities.

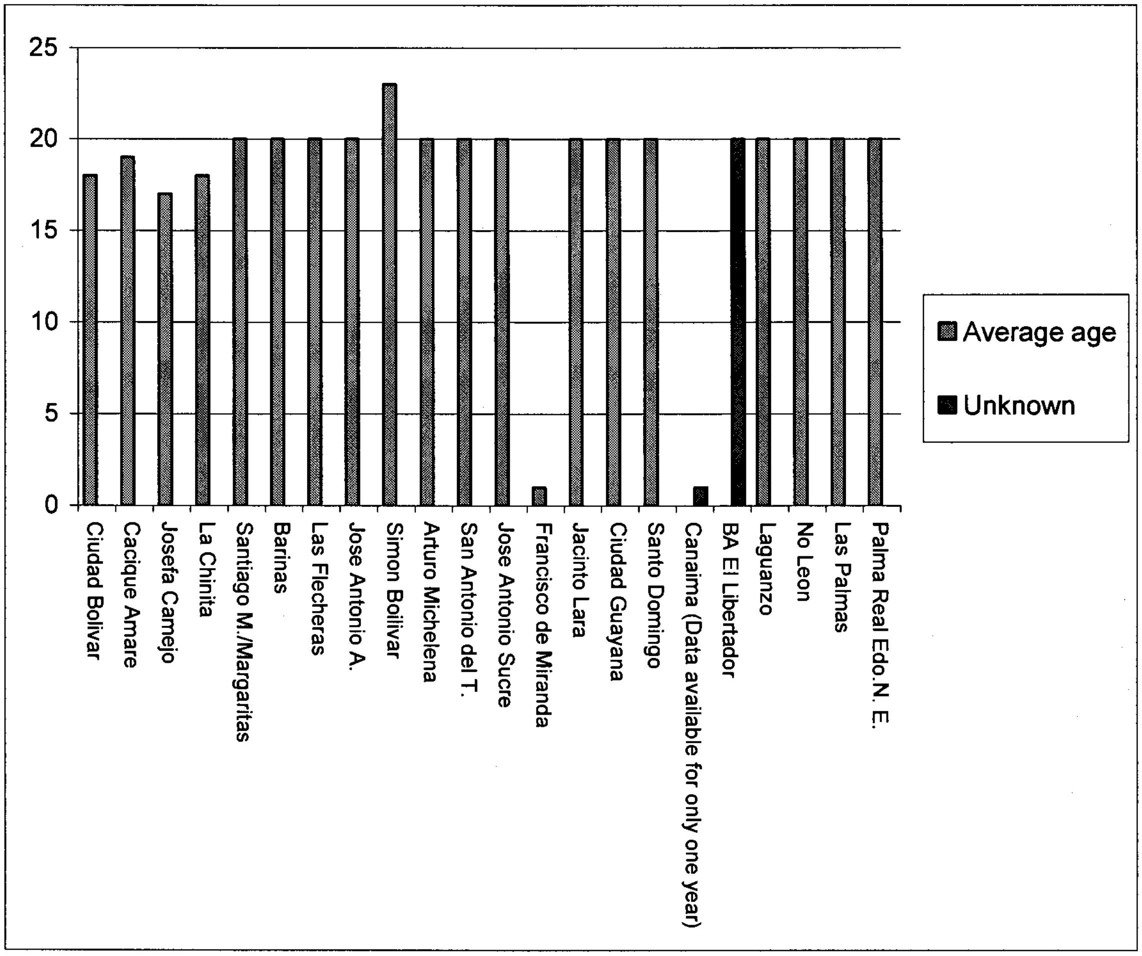
Eastern Venezuela
Barcelona: Jose Antonio Anzoategui Aerodrome, Civil and Military/Approach Control, ILS
Cumana: Jose Antionio Aerodrome, Civil and Military, NDB, VOR/DME
Margarita: Intl. Del Caribe Gral. S. Marino Aerodrome, Civil and Military, Radar Approach Control, ILS
Ciudad Guayana: Puerto Ordaz Aerodrome, Civil and Military, VOR
Ciudad Bolivar: Ciudad Bolivar Aerodrome, Civil and Military; NDB, VOR
Las Palmas: Communication Site
Palma Real: Communication Site
Canaima: Canaima Aerodrome, Civil, NDB
Central Venezuela
Valencia: Arturo Michelena Aerodrome, Civil and Military, NDB
Caracas: Francisco de Miranda Aerodrome, Civil and Military, ILS, VOR/DME
Maiquetia (3 sites): Simon Bolivar Aerodrome, Civil and Military/Radar Approach Control, Area Control Center, Flight Information Services, ILS, VOR/DME, NDB
No Leon: Navigation—VOR/DME
Lagunazo: Communication Site
Cacique Amare: Puerto Ayacucho Aerodrome, Civil, NDB, VOR
Western Venezuela:
Barinas: Barinas Aerodrome, Civil and Military, NDB
Santo Domingo: Santo Domingo Aerodrome, Civil and Military, ILS, NDB
Barquisimeto: Barquisimeto Aerodrome, Civil and Military/Radar Approach Control, ILS (Cat II), VOR/DME
Maracaibo: La Chinita Aerodrome, Civil//Radar Approach Control, NDB, ILS, VORTAC, DME
Paraguana: Josefa Camejo Aerodrome, Civil, NDB, VOR
El Vigia: J.P. Perez Aerodrome, NDB

Communications

The analysis of the data collected during the site surveys supports the prediction made by the Communications Inspector for the Caracas region: "the communications system supporting the Caracas region, specifically the Area Control Center (the only control center in Venezuela) will experience a critical system failure within the next three years that will render the system inoperative for an extended period of time."

It was concluded that VHF/HF operational readiness for the entire Venezuelan airspace system will continue to decline, thereby resulting in a deterioration of aircraft/airline operational efficiencies; increased airborne and ground delays, an overall decline in aviation safety and an increased probability of an aircraft accident/incident.

Overall communications system performance is summarized in the following two tables. It captures average system failures as reported in the project questionnaire. Day by day, various failures and repairs can alter the specific distribution of failures; this diagram instead reflects a typical snapshot of the overall system.

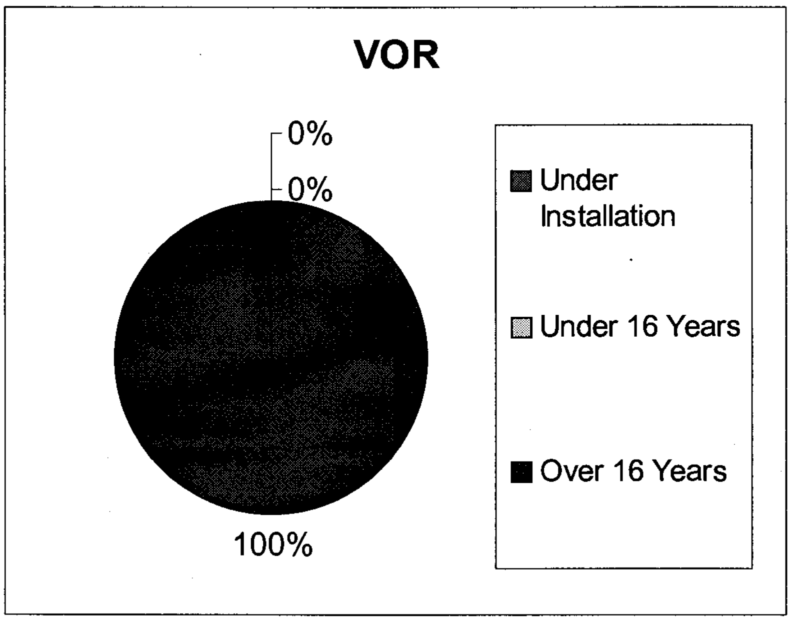


Navigation

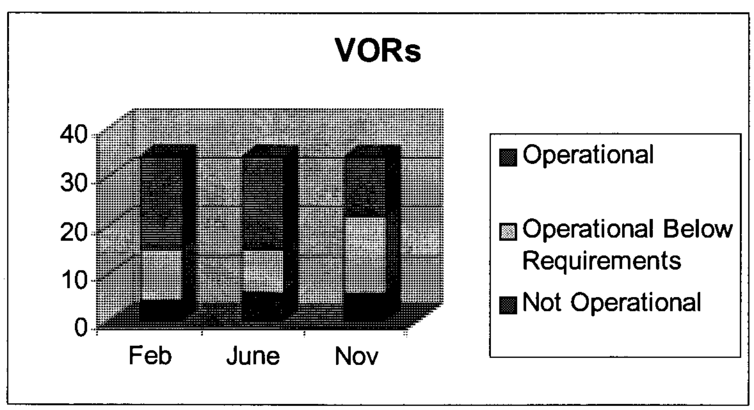
VOR/DME

VOR/DME equipment is primarily Wilcox systems Model 585B. The age of this equipment ranges from sixteen to twenty years. Spare parts for the equipment are depleted; obtaining spare parts from original equipment manufacturers usually is not possible; after-market parts suppliers have not been identified and are presumed unavailable; independent contracting for the manufacturer of spare parts is not considered cost effective. Continued operation of the equipment will likely be sporadic, reliability and operational availability rates will continue to decline.

VOR/DME operational readiness for the entire Venezuelan airspace system will likely decline, thereby resulting in a deterioration of aircraft/airline operational efficiencies, increased airborne and ground delays and reduced aviation safety



Age VOR/DME Systems Based on Questionnaire Response

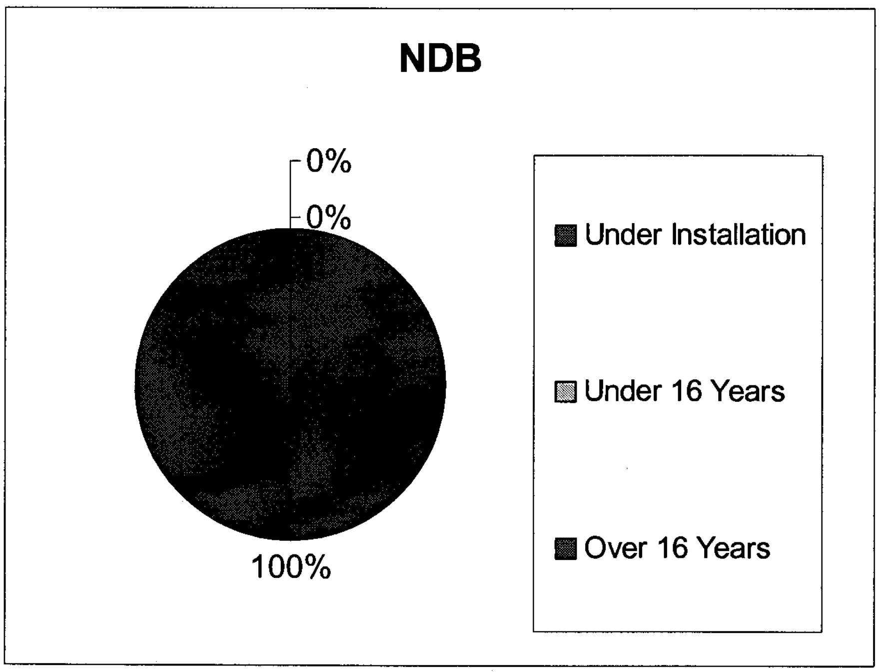


VOR System Status 2002

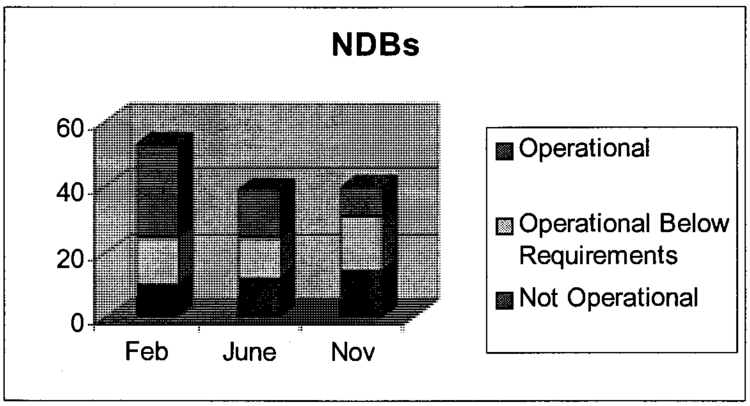
NDB

NDB equipment is a mixture of Aerocom Systems installations. The age of this equipment ranges from twenty to thirty-five years old. Spare parts for the equipment are depleted; obtaining spare parts from original equipment manufacturers usually is not possible; after-market parts suppliers have not been identified and are presumed unavailable; independent contracting for the manufacturer of spare parts is not considered cost effective. Continued operation of the equipment will likely be sporadic, reliability and operational availability rates will continue to decline. Specific data on failure rates were not available, but general estimates from technical personnel indicate one to two failures per year. However, failure rate statistics are not considered reliable since many of the previous repairs have been made using locally fabricated replacement parts and/or obtaining used parts from inoperative equipment.

NDB operational readiness for the entire Venezuelan airspace system will likely decline, thereby resulting in a deterioration of aircraft/airline operational efficiencies, increased airborne and ground delays and reduced aviation safety.



Age Distribution of NDB Systems Based on Questionnaire Response

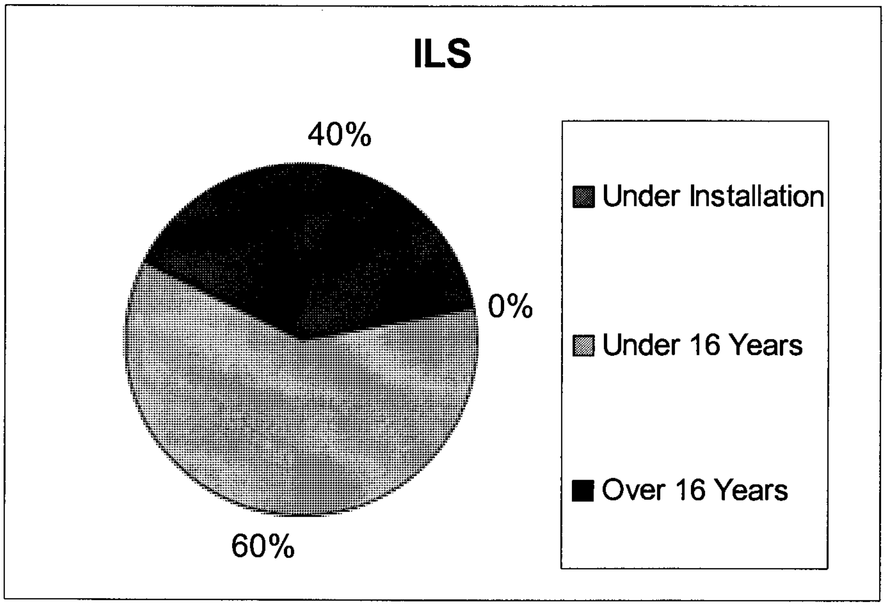


NDB System Status 2002

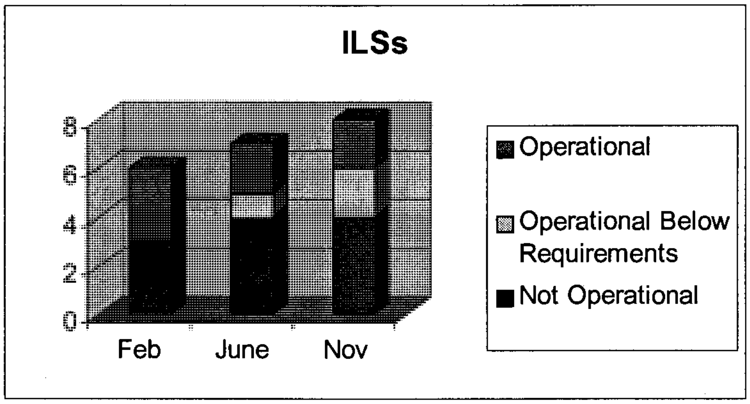
ILS

ILS equipment is primarily Thompson systems installations. In general and as documented by the data collected and information obtained from maintenance personnel, the age of this equipment ranges from one to eighteen years. Spare parts for the equipment are available from the manufacturer. However, few spare parts are available to the technicians for repairs. As reported by the technicians—spare parts are requested through appropriate channels, are seldom received. Continued operation of the equipment will be a function of spare parts availability. Since few spare parts are available, repair rates (i.e., mean-time-to-repair) will likely increase. Current meant time to repair is estimated at one (1) hour.

Overall navigation system performance is summarized in the following table. It captures average system failures as reported in the project questionnaire. Day by day, various failures and repairs can alter the specific distribution of failures; this diagram instead reflects a typical snapshot of the overall system.



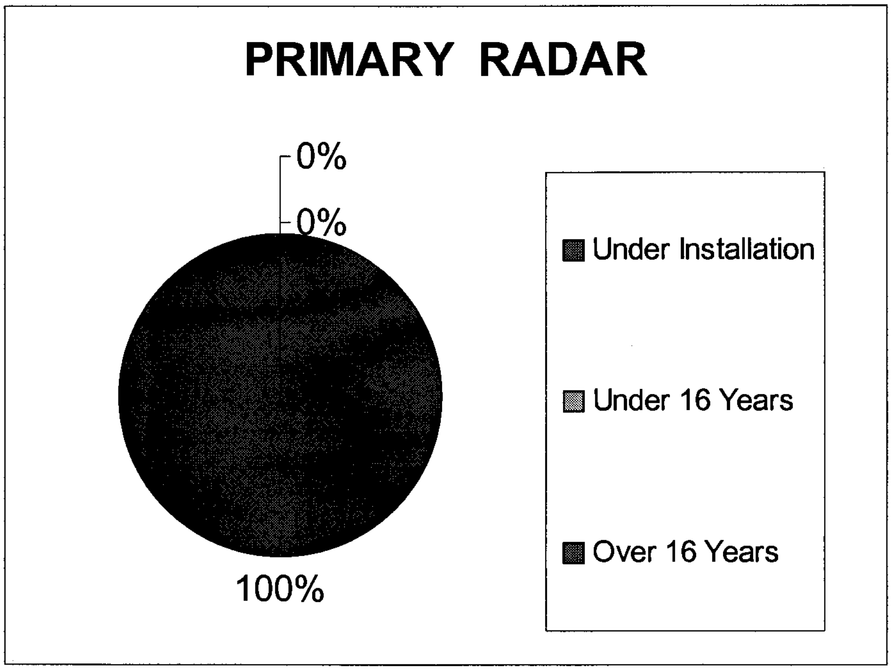
Age of ILSs Based on Questionnaire Response

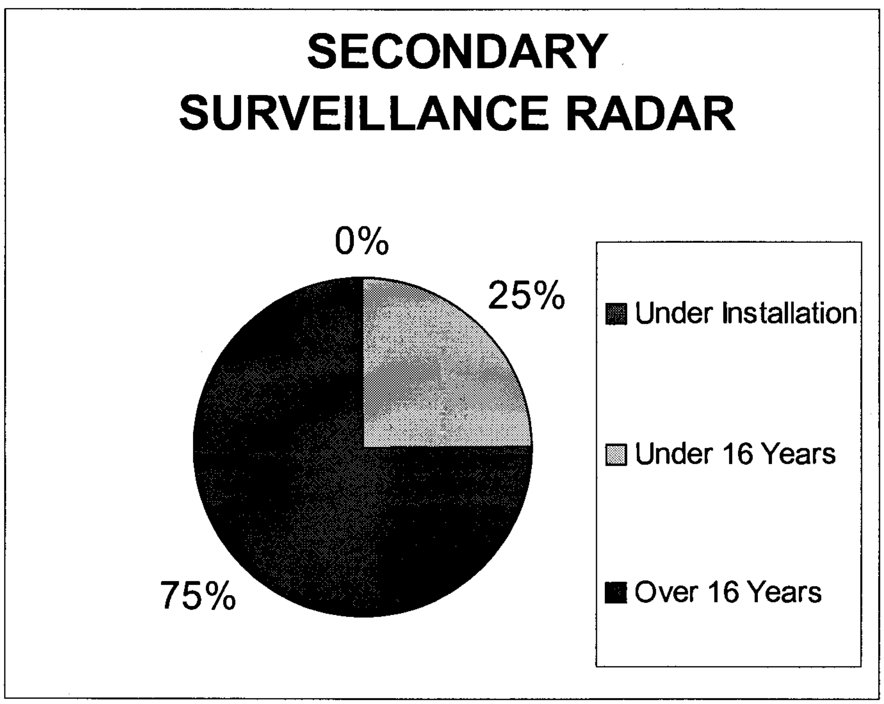


ILS System Status 2002

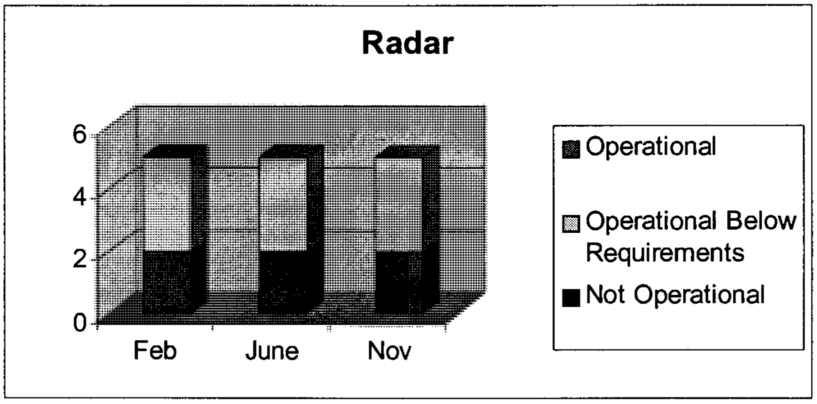
Surveillance

There are five civil radar sites in Venezuela. All sites have both primary and secondary radar capabilities. Radar equipment is a mixture of Texas Instrument (primary-ASR-8) and Cardion (secondary) systems, except for one site equipped with primary and secondary Selenia systems. The Texas Instrument and Cardion systems have been in service from twenty-one to twenty-eight years. Spare parts for the equipment are not available to affect repair of the systems. For instance, at the Maiquetia radar site, one of the primary radar channels failed more than a year ago and has not been repaired due to the lack of spare parts. The radar at Barquisimeto is not usuable because its display does not operate and necessary spare parts for repairs are not available. The secondary radar system at Maracaibo airport (Selenia) may be repairable, if appropriate spares can be purchased from Alenia/Marconi. The radar facility at Barquisimeto is badly vandalized. According to data obtained from air traffic personnel at Maiquetia, on the average a radar failure occurs every 3 months and is usually out of service for 20-30 minutes.





Age of Primary and Secondary Surveillance Systems Based on Questionnaire Response



Status Radar 2002

Environmental Analysis

Both natural and man-made environmental conditions affect the ability of air traffic controllers to execute their daily activities and restrict the coverage of line-of-site transmissions. Site-specific operating conditions and the affect of natural and man-made conditions for each site surveyed are contained in the site evaluation reports.

Airport and facility security appears to be a problem and affects overall CNS/ATM system operations. Repeated occurrences of theft and vandalism were evident at most sites visited. Runway and taxiway lights have been stolen and broken; on-site personnel reported attempts to break into some of the physical facilities; physical damage was observed. For example, in December 2001, a stranger walked into the Maiquetia ACC and requested beer money from the controllers while they were controlling aircraft.

Our Team reviewed all site-specific information and considered the comments/observations made by on-site personnel, it was concluded that there is an urgent need to develop and/or update emergency/natural disaster contingency plans and guidelines for each airport surveyed. Past events indicate that prior planning efforts have either not been undertaken or the plans were ineffective.

It was also concluded that additional attention should be paid to improving levels of security for both airport and off-site equipment facilities as well as conducting flight safety and obstruction assessments for each airport.

Aviation Operations

Airspace operations within Venezuela are predominantly procedural. Radar facilities and consequential coverage are limited.

To assure safe separation between aircraft, controllers must confirm aircraft position location. An aircraft will report its position based upon distance and/or position relative to a known navigational system (e.g. VOR/DME, NDB). As noted earlier, several of the navigational aids in Venezuelan airspace experience periods of outage or are inoperative. Consequently, aircrews frequently experience difficulties in determining their location relative to a known, ground-based navigation fix.

Further complicating the ability of the controllers to conduct procedural airspace separation, are the conditions and reliability of air-ground communications systems. VHF/HF communications systems are typically unreliable and operational readiness rates are declining. Consequently, even when ground-based navigation systems are operational and aircrews can determine aircraft position relative to the known navigation system; they can still have difficulty communicating aircraft position to the controller.

The result of the problems with navigation and communications systems performance is that controllers impose large separation distances between known aircraft operating in a region to ensure adequate safety. Controllers also delay aircraft on the ground until they can positively determine the location of potentially conflicting aircraft.

Procedural separation is labor intensive and stressful on controllers. Venezuela has a single control facility at Maiquetia with responsibility for en route operations and terminal approach control services for several airports. Maiquetia currently has six sectors, but, as noted by the Chief of Maiquetia operations, ten sectors are needed to provide adequate air traffic services. For instance, Sector 5 must provide approach control services for 6 airports.

Airspace capacity does not currently appear to be a problem in Venezuelan airspace, but the ability to assure positive aircraft control and separation is a problem. It was concluded that restructuring of the airspace would benefit overall air traffic operations and safety. The restructuring should take into consideration the current condition of the CNS/ATM support systems; opportunities to adopt space-based systems and services (e.g. Global Navigation Satellite System-GNSS); current and projected traffic flows; controller workloads; economic and countrywide growth opportunities (e.g. the Venezuelan Amazon region); and overall INAC CNS/ATM modernization plans.

Human Resources

Both operations and maintenance civilian work forces are composed of older employees. It will likely be beneficial to recruit young personnel and adequately prepare them to assume operations and maintenance positions as the older employees retire and/or reach a point where they can no longer satisfactorily fulfill their prescribed duties.

All technical and operational staff identified need for further training. It would be beneficial to establish a standardized series of refresher training course for both maintenance and air traffic controller personnel. Although air traffic personnel appeared satisfied with the training courses they received in their initial training courses, every interviewed staff member indicated a need for renewing that training—a consideration, considering the length of time many have worked since their initial training. Moreover, current maintenance and operations training courses are outdated, and need to be refreshed to reflect current maintenance/air traffic control trends and procedures.

Poor environmental conditions have had significant morale impact, particularly on the air traffic control staff. While the operation of airports lies outside of INAC control, unsafe conditions are degrading staff job satisfaction. Common problems included non-functioning bathrooms, disintegration of buildings, noisy towers, broken furniture, lack of proper glass shading and malfunctioning heating/cooling systems in work areas. Most of these problems are inexpensive to repair and should be emphasized as an important condition for INAC service.

Current Venezuelan policies regarding mandatory civilian retirement and retirement compensation needs to be reviewed and possibly restructured. The current civilian policies are not being enforced and are considered meaningless to the current workforces.

General standards and policies need to be developed regarding the number of operations and maintenance personnel required to performed air traffic controller duties and CNS/ATM maintenance functions. Based on these general standards and policies, site-specific criteria/personnel staffing levels need to be developed for each type of CNS/ATM facility (e.g. ACC, approach control, tower, communication, navigation, surveillance maintenance staffing levels for each site location, as appropriate).

National Aviation System Requirements

CNS/ATM Implementation Transition Paths

Based on the constraints identified in previous sections, the implementation of CNS/ATM in Venezuela is targeted at reducing flight constraints along a pre-defined transition path while maintaining the current high level of system safety. The objective of this analysis is to tie realization of each of these stages with defined system benefits and requirements. In doing so, appropriate investment decisions by air traffic service providers and airspace users can be made, which equates to satisfying requirements. Therefore, with some modifications and tailoring, the actions required to relieve, ease, or eliminate these constraints can be considered as CNS/ATM system requirements.

The future air traffic system will be characterized by performance-based technology. This performance-based technology includes Required Communications Performance (RCP), Required Surveillance Performance (RSP), Required Navigation Performance (RNP) and Required Total System Performance (RTSP). This means that flight will be based on the performance capabilities of the aircraft for flight in different areas of airspace. Aircraft will have to satisfy certain communications, navigation and surveillance performance requirements that eventually will result in a total system performance capability. These requirements will be satisfied by the performance capabilities of on-board equipment. For example, flight in certain airspace may require aircraft to have a certain required communication performance (RCP) to use it. This RCP may be met through a mixture or variety of communications equipment or by one piece of communications equipment rather than a specific type of communications equipment required by the provider. In fact some of the on-board communications equipment may not, by itself, qualify for flight in that area. A required navigation performance (RNP) value may be assigned to certain airspace and as long as the aircraft meets the RNP, it doesn't matter what navigational system the aircraft chooses to use to meet the RNP. Future flight will specify certain aircraft performance requirements and it is up to the aircraft as to how it meets those requirements as long as the aircraft is certified for flight in that airspace. Airborne performance requirements will reduce the need for certain equipment on the ground; therefore, providers must take into consideration airborne performance-based requirements when determining their own system requirements.

With the exception of RNP, these technologies are still in the development. However, RNP is a fully developed technology that is being used in many sections of the world today and has been considered in developing Venezuela's future requirements.

REGIONAL NAVIGATION REQUIREMENTS*					
	CURRENT CAPABILITIES		MINIMUM FUTURE REQUIREMENTS		
Phases of Flight	Minimum	Maximum	Phase I (2004)	Phase II (2009)	Phase III (2017)
Oceanic En route	100nm/20min (RNAV)	100nm/20min (GNSS/ RNAV)	50nm/10min RNP-10	30nm/10min RNP-4	30nm/10min RNP-4
Domestic En route	100nm/20min (NDB)	100nm/20min (VOR/DME/ RNAV)	50nm/10min RNP-10	30nm/10min RNP-4	15nm/5min RNP-2
Terminal International	RNP-4 (VOR/DME)	RNP-4 (VOR/DME)	RNP-2	RNP-2	RNP-0.3
Terminal Domestic	RNP-4 (NDB)	RNP-4 (VOR/DME)	RNP-4	RNP-2	RNP-1
Approach International	RNP-0.3 (VOR/DME / GNSS)	CAT II (ILS)	APV-I** RNP-0.3	CAT I PA ILS/MLS/GLS	CAT II/III PA ILS/MLS/GLS
Approach Domestic	RNP-.03 (GNSS)	CAT I (ILS)	NPA RNP-0.3	APV-I** RNP-0.3	CAT I PA ILS/MLS/GLS
Surface	Not Available	Not Available	Not Available	Not Available	TBD
			Supplemental	Primary	Sole Means

* All RNP values are in nautical miles (nm) unless otherwise indicated

** APV-1- approach with vertical guidance; landing minimums lower than VOR NPA, decision height 250 feet

SBAS- Satellite-based Augmentation System, e.g., WAAS, EGNOS, GAGAN

GBAS- Ground-based Augmentation System, e.g., LAAS

Regional Navigation Requirements

RNP Spacing

RNP	SPACING	ATC REQUIREMENTS		
		COMMUNICATIONS	NAVIGATION	SURVEILLANCE
RNP-20	185 km (100 NM)	HF voice/relay	RNP -20	Pilot Reports
RNP-12.6	110 km (60 NM)	HF Voice/relay	RNP-12.6	Pilot Reports
RNP-10	93 km (50 NM)	HF Voice/relay	RNP-10	Pilot Reports
RNP-5	30.6 km (8-12 NM)	VHF Voice	RNP-5	Pilot Reports

note 1: Spacing was not developed for remote or oceanic airspace where VOR infrastructure was not available and not validated by collision risk models.

note 2: The navigational aid infrastructure must be sufficient to support the appropriate RNP and the system safety must be evaluated periodically.

note 3: The basis for RNP-12.6 and RNP-10 were evaluated through collision risk models performed by the NAT Organized Track Structure (12.6), and by the Federal Aviation Administration for the Pacific Region based on North Pacific characteristics.

note 4: Direct communications may be desirable in certain areas

note 5: Relay indicated in the communications column indicates a third party that relays information between the provider and the user, usually ARINC or SITA. States with their own HF would not use a relay

Radar Environment

RNP-4	14.8 -22.2 km (8 -12 NM)	VHF Voice	RNP-4	Radar
RNP-5	18.5 - 27.8 km (10 -15 NM)	VHF Voice	RNP-5	Radar

note 6: In the radar environment, the radar must meet existing standards and the containment areas must not overlap.

note 7: Aircraft must be certified for the appropriate RNP.

Current System Equipment and Operational Requirements

There are two flight environments in domestic airspace, radar and procedural, although area navigation or RNAV is permissible in both. Oceanic flight is predominately procedural. In the domestic area, there are basically three phases of flight, en route, terminal (arrival and departure) and approach, although with CNS/ATM, surface management or the movement of aircraft on the ground has become a phase of flight for both equipment and benefit purposes. The communications and navigation requirements are the same for en route and terminal, but vary in the approach phase based on the aids used for the approach. The surveillance requirement is either radar or position reports. For the present, ground movements are tower directed and conducted under visual means.

These airborne requirements associated with the following chart are based on Annex 6, Operation of Aircraft, which in part states that aircraft must carry the appropriate avionics (navigational receivers) for the routes to be flown. The States determine, provide and approve the navigational equipment used in their airspace and the aircraft must comply to operate in that airspace. The Venezuelan AIP indicates the use of VOR and NDB for navigation has been approved in Venezuela; therefore aircraft must comply by having, at a minimum, a VOR and/or an NDB receiver in the aircraft to fly IMC in Venezuela. The CAR/SAM CNS/ATM Plan indicates that Venezuela has already approved GNSS as a supplemental means of navigation thereby permitting GPS to be used in Venezuela by aircraft that are equipped. It has been the opinion of ICAO that most all aircraft will equip voluntarily in order to receive the benefits of CNS/ATM.

ICAO has long recommended that States provide two-way communications within their FIR and that has been confirmed in the CAR/SAM Region (CAR/SAM/3, Rec. 5/16). Additionally, the Venezuela AIP requires that aircraft that operate IMC have direct communications with the provider. However, due to the topography of Venezuela and a lack of VHF platforms, it is not always possible to have direct VHF communications. But the requirement for direct VHF communications still exists. HF can provide direct communications and has been used as an alternate for VHF, but HF suffers from noise propagation and transfer delay. This makes it unusable in a domestic environment where rapid response time is essential. HF is used in the oceanic environment and the term "relay" that is indicated in the communications column in the oceanic portion refers to a third party who provides HF messages between the users and providers. This service is usually provided by ARINC and SITA for providers who do not maintain HF equipment. The only surveillance require at present is position reports (Annex 11). Where radar surveillance is presently in effect, MSSR has been added as a requirement.

Oceanic procedures are based on long flights with airborne navigational aids that are not as accurate as ground-based aids that require extensive separation criteria. Oceanic flight at present requires two-way voice communications using HF relay or direct, navigational aids such as Omega, inertial, or GNSS (GPS) and pilot position reports for surveillance. Flight Management Systems (FMS) are considered a navigational capability due to the redundant inertial navigation systems interfaced with the FMS.

			Activity	Communications	Navigation	Surveillance
OCEANIC			1. Flight in Oceanic Airspace 20 min in-trail Mach Technique required	HF Voice/Relay	Omega/IRS/GPS/FMS	Position Reports
OCEANIC			2. Flight on Oceanic Routes 10 min in-trail Mach Technique required	HF Voice/Relay	Omega/IRS/GPS/FMS	Position Reports
DOMESTIC	ENROUTE		Procedural	VHF/HF Voice	VOR/DME/NDB/GPS	Position Reports
DOMESTIC	ENROUTE		Radar	VHF/HF Voice	VOR/DME/NDB/GPS	MSSR
DOMESTIC	ENROUTE		Random (RNAV)	VHF/HF Voice	GPS/IRS/FMS	MSSR or Position Reports
DOMESTIC	TERM		Procedural	VHF Voice	VOR/DME/NDB/GPS	Pilot Reports
DOMESTIC	TERM		Radar	VHF Voice	VOR/DME/NDB/GPS	MSSR
DOMESTIC	TERM		Random (RNAV)	VHF Voice	VOR/DME/NDB/GPS	MSSR/or Position Reports
DOMESTIC	APCH	NPA	VOR/DME	VHF Voice	VOR/DME	MSSR or Position Reports
DOMESTIC	APCH	NPA	NDB	VHF Voice	NDB	MSSR or Position Reports
DOMESTIC	APCH	NPA	GNSS	VHF Voice	GPS	MSSR or Position Reports
DOMESTIC	APCH	P	ILS	VHF Voice	ILS	MSSR or Position Reports
DOMESTIC	DPT		Procedural	VHF Voice	VOR/DME	Pilot Reports
DOMESTIC	DPT		Radar	VHF Voice	VOR/DME/Vectors	MSSR
DOMESTIC	S		Surface Management	VHF Voice	Visual/Tower Directed	Visual/ASDE/Pilot Reports

Current Operational Requirements for En Route Flight

Air Traffic Management Requirements

Just as there are CNS requirements that must be met by the aircraft operators, there are also ATM requirements that must be met by air traffic providers. The ATM objective that has been accepted by ICAO and adopted as an ATM requirement by the CAR/SAM Region (paragraph 1.5.6.1 of the CAR/SAM Regional CNS/ATM Plan) is as follows:

"The objective of ATM is to enable aircraft operators to meet their planned times of departure and arrival and adhere to their preferred flight profile with minimum constraints without compromising agreed levels of safety."

This objective is restated in the CAR/SAM ANP, Part V and paragraph 6. This requirement is very broad, therefore, it must be broken down into sub-topics in order to implement. For example, that portion of the objective that states "to enable aircraft operators to meet their planned times of departure" relates to the filing and processing of flight plans, ATC departure clearances, meteorology, aeronautical information, flow restrictions, etc. All these sub-topics need to be satisfied in order for an aircraft operator to meet his planned departure time. Therefore, they can be considered as required actions. The required actions identified in the following tables have been tailored to the needs of Venezuela.

Phase of Flight	ICAO/CAR/SAM Recommendations	Required Actions	Venezuela Targets
Flight Planning	Provide aircraft operators with information that will enable them to plan flights for optimum profile/route/ trajectory, to meet their planned departure time (CAR/SAM ANP, Part V, paragraph 6)	Integration of information on capacity constraints at ACCs and airports to provide optimum airport scheduling information (extrapolated from main requirement)	2005
		Integration of ATC and ATFM information together with decision-making tools to accommodate late flight plan changes (paragraph 4.43, ICAO Global CNS/ATM Plan);	2006
		Provide user access to interactive, integrated flight information to include real time data in AIS, MET, ASM, ATFM for flight plan filing purposes (CAR/SAM ANP, Part V, paragraph 7 & 11; CAR/SAM CNS Plan; Chapter 9 and Chapter 8))	2006
		Enhance Flight Plan Data Processing (FPDP) to access tactical ASM , ATC, ATN, and ATFM information to include the use of repetitive flight plans (CAR/SAM/2 Rec. 6/3)	2004/05
Airport Surface and Taxi	Maximize runway and taxi-way utilization to ensure minimum taxi time between departure gate and take-off to meet planned departure times	Adequate airport surveillance that includes ASDE, ADS-B, or SMGCS where needed (ICAO CNS/ATM Plan, CAR/SAM ANP, CAR/SAM/3, Rec. 11/2 (ADS if radar not possible)	2007 2004
	Maximize runway and taxi-way utilization to ensure minimum taxi time to enable operators to meet their planned arrival time (CAR/SAM ANP, Part V, paragraph 6)	Automated terminal information service (CAR/SAM/3 Rec. 5/17) Pre-delivery clearances (CAR/SAM /3, Rec. 5/34)	2004

Phase of Flight	ICAO/CAR/SAM Recommendations	Required Actions	Venezuela Targets
Departure and Approach	To provide for a smooth transition from the departure phase to the en route phase so aircraft can adhere to their planned flight profiles To maximize runway utilization and provide for a smooth and seamless transition from the en route phase to the approach phase so aircraft can meet their planned times of arrival (CAR/SAM ANP, Part V, paragraph 6)	Optimize arrival and departure routes utilizing SIDs and STARs; (CAR/SAM/3, Rec. 5/32) Improve the overall efficiency of airport operations (Basic ANP, paragraph 22c) Optimize airport instrumentation for local weather measurement. (CAR/SAM CNS Plan, sub-chapter 8.3, paragraph 8.3.3) Provide metering and sequencing tools (CTAS; P-fast, URET, TMA) (Not a requirement; but needed)	2005 2004 2005 2006
En route	To make the en route phase of flight a seamless phase of flight so that aircraft can adhere to their planned flight profiles without compromising agreed levels of safety (CAR/SAM ANP, Part V, paragraph 6)	Revise institutional procedures to facilitate gate-to-gate operations; (extrapolated from main requirement) Inter-relate ASM, ATS, and ATFM polices and integrated information systems (CAR/SAM ANP, paragraph 12) Compatibility of air and ground systems (Basic ANP, Table Intro-2) Enhance ground systems with airborne systems (Basic ANP, Table Intro-2) Utilize RNAV/RNP procedures (CAR/SAM/3, Rec. 5/16)) Improve the overall efficiency of airspace operations (Basic ANP, paragraph 22c). Increase the availability of user preferred schedules and flight profiles (ANP, paragraph 22d)	2004 2005 2006 2005 2003 2005 2006

Future ATM Initiatives and System Requirements

The following tables represent the many ATM initiatives and services that should be offered in a CNS/ATM environment and the equipment technologies that are needed to support these initiatives. While a few initiatives may have been omitted, we believed we have covered the majority of the important initiatives in a CNS/ATM environment. We have grouped the initiatives into the 6 phases of flight as they relate to the phase outline in this document. We have also indicated the required actions or sub-actions that must be completed to satisfy the major requirement. In some cases, the required actions outlined in these tables are components of the required actions mentioned in ATM Requirements. Once again the major ICAO/CAR/SAM objective is to "enable aircraft operators to meet their planned times of departure and arrival and adhere to their preferred flight profile with minimum constraints without compromising agreed levels of safety." Each phase of flight has a set of requirements that are derived from this objective.

Equipment is not a requirement, but only a method to satisfy an objective or a requirement. For example, radar is not a requirement; surveillance is the requirement. Radar is a means, but not the only means, of satisfying the surveillance requirement. However, ICAO has recommended that states consider radar as a surveillance tool in complex, high volume traffic areas. In our options, we will indicate target dates when ATM initiatives should be implemented.

Once the provider makes a valid decision to provide a service (sub-actions), either through regulation or selected option, this service then becomes an operational requirement and the equipment required to support this service becomes a systems requirement. How the provider satisfies that requirement is a State's right. For example, if a State decides that enhanced surveillance beyond that of position reports is required, then radar or ADS becomes a requirement. Another example is the use of GNSS. ICAO recommends that States implement GNSS by 2010. The recommendation or requirement is "satellite navigation". States make the decision as to how to implement "satellite navigation". It may choose GNSS by itself, or it may add an SBAS and/or a GBAS. Remember that each level of GNSS increases cost as well as adding additional benefits. Once the State decides which level of GNSS it will implement, the equipment required to support that decision becomes a requirement.

MINIMUM DOMESTIC ATM EQUIPMENT REQUIREMENTS

Phase of Flight	ICAO/CAR/SAM Recommendation	Required Actions	Communications	Navigation	Surveillance	Miscellaneous Equipment
Airspace and Flight Planning	Annex 11, ICAO Global Plan, paragraphs 4.39 and 4.52	1-Flight data processing and strip dissemination	AFTN/AMHS			FDEP, ATM
	Annex 11	2-AIS/NOTAMs	AFTN/AMHS			WAFS/imagery
	Annex 11, CAR/SAM /3, Rec.5/34	3-ATC clearances ,	VHF voice/ VDL M2			
	CAR/SAM/3, Rec. 5/17	4-ATIS	VHF/VDL Mode 2/AOA			
	CAR/SAM/2, Rec. 6/3	5-Use of repetitive flight plans				FDEP ATM system
	ICAO CNS/ATM Plan paragraph 4.59	6-Integration of SMA and ATFM	AMHS/Public telecom.			Flow Control Automation
	ICAO CNS/ATM Plan paragraph 8.12	7-Meteorology				Satellite Imagery

1- Flight Data Processing and Dissemination. Flight plans are distributed to providers via the AFTN. The AFTN is being replaced by the AMHS which is ATN compliant. The AMHS software is available and has been implemented in only a few States thus far. The United States will implement AMHS starting in 2003. Venezuela should maintain the AFTN until it is replaced by AMHS. This is the initial component of the ATN. Flight plan processing can be completed manually, but automation has reduced this time consuming task. The Flight Data Processor will process flight plan information, record all overflight aircraft as they enter/exit the FIR, process flight times and aircraft type for over flight fee collections, provide strips for each control position, perform coordination functions, reduce the excessive coordination requirements at the busier facilities and will eliminate the manual processing and counting of strips and aircraft movements. An ATM system can do all the things an FDEP can do and more. The ATM is both an FDEP and a radar data processor. The FDEP is for States without radar and an ATM system is for States with or who intend to purchase radar. Both provide flight progress strips and forwards a strip to the tower for clearance delivery to the aircraft. ICAO has recommended the filing of flight plans be a coordinated effort between the provider and the user so that the flight profile accommodates the user's preferred trajectory with minimum ATM constraints. The FDEP nor the ATM system are ICAO requirements. Only the processing of flight data is an ICAO recommendation.

2-AIS/NOTAM Aeronautical information must be processed and disseminated to the users. NOTAM information , along with meteorological and airspace information (special use airspace), must be processed and disseminated as well. The AFTN and/or AMHS is the medium used to disseminate this information.

3. ATC Clearances. ATC departure clearances are a result of a flight plan request. At present, ATC clearances are delivered directly to the aircraft through VHF voice or by voice relay. The new technology to deliver an ATC clearance is via data link. An initial data link application is pre-departure clearances (PDC). This technology is presently offered through ARINC or SITA via an ACARS link, but is being supplanted with VDL Mode 2. PDC eliminates transposing errors and mis-read clearances. The use of PDC is quicker and relieves clearance delivery workload. In a busy terminal such as Maiquetía, PDC would be a time-saving, man-power saving technology. PDC is not an ICAO or CAR/SAM requirement; only the issuing of an IMC clearance to international air carriers is an ICAO recommendation

4. ATIS The use of ATIS is an ICAO recommendation. Most airports have it, but it is a taped message and aircraft monitor a frequency to hear it. The new technology for ATIS is digitized data link known as D-ATIS. It is presently being used as an ACARS application but is being converted to VDL Mode 2. AOA (ACARS over VDL M2) may be used for D-ATIS. ATIS is an both an ICAO and CAR/SAM recommendation, but only CAR/SAM has recommended it for use over a data link. However, ICAO has recommended the use of data link technology where applicable.

5. Use of Repetitive Flight Plans Another name for this is "stored flight plans". Aircraft operators that have aircraft departing at the same time and going the same place via the same route have a stored flight plan on file with the provider. This eliminates the need to file a flight plan every day. CAR/SAM has recommended the use of "repetitive flight plans. Flight plans are stored via a computer and processed approximately 2 hours prior to a scheduled departure. Repetitive flight plans can be stored via an FDEP or ATM system. If Venezuela considers this recommendation as law. then an FDEP or ATM system would be a requirement.

6.-Integration ASM and ATFM This is CAR/S recommendation to integrate airspace management with flow control. At the present Brazil is exploring the development of South American Flow Control Facility. If this becomes a reality, Venezuela will be required to process flow programs, provide data to the central facility, adhere to flow restrictions developed by the flow facility.

7.- Meteorology Although Venezuela is aware of need for advance meteorology support for the future air navigation system, ICAO has recommended the need for extensive satellite imagery. This has beeb ehoed by CAR/SAM Region in their CNS/ATM Plan and the Air Navigation Plan. The need obtain automated global upper wind/temperature and SIGWX forecast, and the up-and down – ink of information from aircraft sensors.

MINIMUM DOMESTIC ATM EQUIPMENT REQUIREMENTS

Phase of Flight	ICAO/CAR/SAM Recommendation	Required Actions	Communications	Navigation	Surveillance	Miscellaneous Equipment
Airport Surface/ Taxi	Annex 11, ICAO CNS/ATM Plan	1-Airport ground surveillance	VDL M4, Mode S AOA,UAT		ASDE, ADS-B	
	ICAO CNS/ATM Plan Paragraph 4.678	2-Airport management	VDL M2	Tower directed	ADS-B	SMA
	Annex 11, ICAO CNS/ATM Plan, paragraphs 4.54-4.55	3-Taxi instructions	VHF Voice Mode S/UAT/A	Tower directed Pilot directed	visual ADS-B	A-SMGCS

1. Airport Ground Surveillance. ICAO recommends the use of ground surveillance at major, high use international airports. The present ground surveillance system is radar in the form of an ASDE. However, the new technology is ADS-B. ADS-B has been tested and demonstrated, and SARPS have been developed. The problem at this point is what will be used as a unified data link. Mode S and UAT are being used in demonstrations, but many aircraft have not yet been modified for the Mode S 24-bit address. Universal Access Transceiver (UAT) is a transitional link that is used in the United States and it has high potential, but has not matured sufficiently for use elsewhere. VDL M4 is also a candidate for ADS-B, but it has not been approved for public use. SARPs are in final stages of approval. ACARS over VDL M2 (AOA) seems to have high potential, but the SARPS have not been approved as yet. The use of radar or ADS-B is not an ICAO requirement, but has been recommended for those airports that have a need for it.

2. Airport Management. At large airports, aircraft and vehicular traffic has been an on-going safety problem for aircraft utilizing the airport. Vehicular traffic on the airport has surpassed the number of aircraft using the airport. Ground surveillance provides a high degree of safety at some airports, but has limitations. Another automation tool to assist in airport management is Surface Manager Advisor (SMA). Surface Movement Advisor increases awareness of traffic flow into the airport, giving ramp control operators precise touchdown times. This updated information helps airlines manage ground resources at the terminal more efficiently: gates, baggage handling, food services, refueling, and maintenance. Informed of aircraft identification and position in the terminal airspace, gate and ramp operators using SMA have enhanced ability to reduce taxi delays. The ICAO recommendation recommends that States should provide separation between arrival, departing, and taxing aircraft in and around the airport using airport management tools where possible.

3. Taxi instructions. The control of taxing aircraft on an airport surface is the responsibility of the ATC tower. At present controllers verbally through VHF voice transmit taxi instructions to aircraft ensuring their separation between other aircraft and structures. This is a time consuming operation at large airports. Surface surveillance through the use of ADS-B has the potential to relieve the controller's workload. With ADS-B, the pilot can see traffic from a CRT in the cockpit and provide his own separation as he taxis to the runway or to the gate. As mentioned above, there are several data link candidates for ADS-B including Mode S, UAT, AOA, and VDL M4. In the options we present, we will recommend a definitive link for ADS-B. Pilot directed taxi through ADS-B is an improvement over the present standard. Another tool is the Advanced Surface Management Guidance and Control System. A-SMGCS identifies each aircraft, provides surveillance and monitors taxing traffic continuously; it determines automatically conflict-free taxiway routes and guides aircraft and vehicles reliably through the use of optical signals; and in case of deviations, it warns pilots or drivers immediately. As such, this control and monitoring functionality provides controllers with tools to enhance safety, efficiency, and availability at the airport in all visibility conditions.

MINIMUM DOMESTIC ATM EQUIPMENT REQUIREMENTS

Phase of Flight	ICAO/CAR/SMA Recommendation	Required Actions	Communications	Navigation	Surveillance	Miscellaneous Equipment
Departure and Arrival	CAR/SAM /3, Rec. 5/32	1-Standard Instrument Departures	VHF Voice Mode S/ UAT/AOA	GNSS/SBAS GBAS/RNP-1	*MSSR *ADS-B	
	ICAO/CAR/SAM Objective	2-Reduced obstruction terrain clearance	VHF Voice	SBAS/GBAS	*MSSR/ADS	
	ICAO/CAR/SAM Objective	3-Reduced departure and approach minima	VHF Voice/data Mode S/UAT/AOA	GBAS	*MSSR/ADS	
	CAR/SAM/3, Rec. 5/32	4-Standard Terminal Arrival Routes	VHF/AMSS Voice or AMSS Data	GNSS/SBAS RNP-4	*MSSR/ADS	
	ICAO CNS/ ATM Plan paragraph 4.58	5-Metering and sequencing tools	VHF Voice	SBAS/GBAS	*MSSR/ADS	CTAS, P-fast URET
	Annex 11, Annex 10	6-Landing Aids				PAPI, VASI RAILS
	Annex 11, Doc 4444	7. Separation Reductions	VHF Voice/data Mode S/UAT/AOA	SBAS/GBAS RNP-1-4	MSSR/ADS	

1. Standard Instrument Departures. (SIDs) SIDs have the capability to increase capacity, reduce delays, and ease controller workload. Using augmented GNSS (SBAS/GBAS), the route can now be developed to conform with traffic flow rather than position of ground-based aids. Procedures can be designed that permits SIDs to conform to noise abatement and traffic flow. Route widths can be reduced to make better use of airspace configurations and to expedite departures.
2. Reduced Obstruction/Terrain Clearances. GNSS, augmented by SBAS or GBAS, can narrow the RNP value to reduce the distance aircraft must stay from obstructions and high terrain. In the past we have depended on radar to vector aircraft when they passed near obstructions. Now using RNP, we can develop routes that permit aircraft, under procedural control, to fly closer to obstructions that previously would not have been possible. This increases the capacity and reduced delays. ADS, which is available in those areas where radar can not provide a surveillance monitor. The reduction of obstruction and terrain clearance limits is a high priority in ICAO, but the manner in which it is accomplished is a States decision.
3.Reduced Departure and Arrival Minima. GNSS, supported by ADS and RNP, can improve the transition routes for departures and arrival. These routes are not limited as they are with ground-based facilities. Departure transitional routes can be reduced in width and be designed for any type of airspace. Arrival transition routes from the STAR to the initial approach fix and even to the immediate approach fix can be reduced and designed to fit the traffic flow rather than the location of ground-based aids. These routes can also eliminate reverse courses for non precision approaches. Electronic surveillance is required for any RNP below RNP-4.
4. Standard Terminal Arrival Routes. (STARs). The development of SIDs and STARs is an ICAO recommendation and supported by CAR/SAM/3, Rec.5/32. GNSS with augmentation provides the RNP for this profile from the STAR to the immediate approach fix. Radar and/or ADS provides the surveillance, but is not a requirement for this initiative.
5. Metering and Spacing Tools. The use of metering and spacing tools is supported by ICAO in the ICAO Global CNS/ATM Plan, paragraph 4.58Center/Terminal Automated Sequencing (CTAS) and Passive-Final Approach Sequencing Tool (P-fast) are metering and aircraft spacing tools. User Request Evaluation Tool automatically predicts and notifies controllers of conflicts between aircraft or special activity airspace. The system also allows controllers to quickly determine whether proposed flight path changes will conflict with en route traffic or airspace. Radar is required for these tools.
6. Landing Aids. The use of landing aids is supported by both ICAO and CAR/SAM. Landing aids are not a product of CNS/ATM but are necessary to increase capacity and eliminate any delay in the landing process. Precision Approach Path Indicators (PAPIs), Visual Approach Slope Indicators (VASI), and Runway Approach Intensity Lighting System (RAILS) are the most appropriate landing aids.
7. Separation Reductions. At present procedural separation is based on ground-based navigational aids and time with the minimum procedurals separation being 5 or 10 minutes, or 10/20 DME miles. Augmented GNSS, using RNP-1/2 can reduce the lateral separation to 1 or 2 mile laterally. With GNSS, DME standards can be used even though there is no DME facility. Separation can be further reduced utilizing ADS. Separation below 4 miles is not possible without GNSS, and in some cases

D

* Optional

MINIMUM DOMESTIC ATM EQUIPMENT REQUIREMENTS

Phase of Flight	ICAO/CAR/SAM Recommendations	Required Actions	Communications	Navigation	Surveillance	Miscellaneous Equipment
En route	CAR/SAM/3, Rec. 5/16; CAR/SAM/2, Rec. 14/29	1-Point-to-point Domestic Remote/Oceanic (RNAV)	VHF Voice/data VHF/AMSS/HF Voice/data	SBAS /RNP GNSS/SBAS	*MSSR/ADS *ADS	
	CAR/SAM/3 Rec. 5/29	2-RVSM	VHF/AMSS Voice/data	GNSS/SBAS	*MSSR/ADS	
		3-Separation Reductions:				
	CAR/SAM/3 Rec. 5/24	10 min/80 NM	VHF/HF voice/data	GNSS		
	Annex 11, Doc 4444	20 NM (long)	VHF/AMSS Voice/data	GNSS/SBAS	*MSSR/ADS	
	Annex 11 Doc 4444	10 NM (long)	VHF Voice	SBAS	MSSR/ADS	
	Annex 11	4 NM (Lat)	VHF voice	SBAS	*MSSR/ADS	
	Pending	2 NM (Lat)	VHF voice	SBAS	MSSR	
	Pending	5 NM	VHF voice	SBAS	MSSR	
		4-MEA/MRA MOCA		GNSS/SBAS		
	CAR/SAM/2, Rec. 14/31 CAR/SAM/3, Rec. 11/2	5-Surveillance	VHF/AMSS Voice/data	GNSS/SBAS GBAS	MSSR/ADS	

1. Point-to-point (RNAV) Point-to-point or direct navigation is supported through GNSS and its augmentations. GNSS will support RNP-4 or higher but a SBAS is required for an RNP lower than RNP-4. SBSS supports sole means navigation for GNSS and can support RNP-2. GBAS is required for lower RNPs which are generally associated with approaches and departures. VHF/AMSS voice/data will satisfy communications requirements for RNP-4 and higher, but VHF voice is required for RNPs lower than RNP-4 due to intervention. CAR/SAM/2, Rec. 14/29 requires VHF coverage for ATS purposes to permit effective direct pilot-controller communications. Radar or ADS is optional for RNP-4 and higher, but is considered a requirement in areas of RNP-2 or lower.
2. RVSM. RVSM (reduced vertical separation minima) has been recommended for use by both ICAO and the CAR/SAM Region. Certification and monitoring of RVSM certified aircraft through GPS requires no ground based equipment. The use of RVSM using height monitors requires ground based equipment. Our recommendations will focus on the most cost productive method which appears to be GNSS.
3.Reduction of Separation Standards. In those areas where 20 minutes and no in-trail mileage separation standards are uses, the reduction to 10 NM or 80 NM would be considered a reduction in separation minima. CAR/SAM has recommend that each State implement this standard as quickly as possible to be in line with other CAR/SAM states that have implemented it. With the advent of GNSS (SBAS/GBAS) and RNP, the potential for further separation reductions are high. What has normally been 10 or 20 minutes, or 20 DME separation standards can now be drastically reduced. With RNP, lateral standards can be reduced to as low as 2 NM and possibly lower. Longitudinal standards can be reduced from 10 minutes to 10 NM. VHF/AMSS voice/data is required for separation of 10 NM or less. Electronic surveillance is optional with the exception of using 2 or 5 NM lateral separation. Other standards can be reduced such as longitudinal separation between departures, between crossing courses, and between climbing and descending aircraft.
4. Reduction in MEA/MRA/MOCA. MEA (minimum en route altitude) MRA (minimum reception altitude) and MOCA (minimum obstruction crossing altitude) are based on the reception range of ground based navigational aids. MRA determines the MEA since the MEA can not be lower than the reception altitude of the ground based aid. MRAs are based on the reception range of the navigational aid, therefore they are higher in the mountainous and remote areas due to the height of mountains and the distance between aids. The MOCA is based on the MRA and MEA. With GNSS reception of signals

* Optional

MINIMUM DOMESTIC ATM EQUIPMENT REQUIREMENTS

Phase of Flight	ICAO/CAR/SAM Recommendation	Required Actions	Communications	Navigation	Surveillance	Miscellaneous Equipment
Approach	Annex 11, Vol.1 Attachment B	1. ILS	VHF voice	ILS	* MSSR/ADS-B	ILS
	Circular 267 (GNSS) Doc 9613 (RNP)	2. GNSS -Non-Precision				
		-APV-1	VHF Voice	GNSS	*MSSR/ADS	
		-APV-2	VHF Voice	SBAS	*MSSR/ADS	
		- curved	VHF Voice	SBAS/GBAS	*MSSR/ADS	
	Circular 267 (GNSS) Doc 9613 (RNP)	-Precision				
		- CAT I	VHF Voice	SBAS/GBAS	*MSSR/ADS	
		- CAT II	VHF Voice	GBAS	MSSR/ADS	
		- CAT III	VHF Voice	GBAS	MSSR/ADS	
		- parallel	VHF Voice	SBAS/GBAS	MSSR/ADS	

1. ILS Approach. The ILS approach is a precision approach that is based on ILS equipment and RNP is not a factor. The ILS is the onlysystem that provides precision approach other than GNSS precision approaches. The ILS has a life span of about 12 years even with good maintenance principals. ILS has three levels of precision approach; CAT I, CAT II, and CAT III. ICAO recommends that each country have at least one ILS at their major international airport. An ILS monitor is required in the ATC tower so that controllers can advise the aircraft to execute a missed approach if the ILS fails during the approach. VHF communications are required so that controllers can advise the aircraft when the ILS fails. Electronic surveillance is not required but recommended.

2.GNSS Approaches. The following are approaches that use GNSS. Electronic surveillance is optional with the exception of curved or parallel approaches. VHF communications is required since it is in the airport area. GNSS is required for these approaches since the approaches will have an RNP value assigned. All GNSS approaches have been recommended by both ICAO and CAR/SAM Region.

- non-precision - GNSS will be able to provide non-precision approaches in those areas where a precision approach is not possible or where precision approach lighting systems are not available. Approach minimums will be less than conventional non-precision approaches are today. If using GNSS, aircraft must be equipped with ABAS or RAIM. there are no other ground-based requirements other than VHF communications

-APV-1 non-precision - APV-1 approaches are GNSS non-precision approaches that use an electronic glideslope provided by on board avionics. . These are new approaches and have not received final ICAO approval, but have the capability of approach minimum below that of conventional approaches.

-APV-2 non-precision - APV-2 approaches are GNSS non-precision approaches that use an electronic glideslope provided by on board avionics. The approach also requires the use of a SBAS for navigation to obtain the lower minimums. These are new approaches and have not received final approval from ICAO, but they have the potential for approach minimums near what are present CAT I minimums today. The use of this approach may invalidate a requirement for an ILS or precision approach at some airports.

-curved - Using GNSS, curved approaches can be constructed that permit aircraft to make approaches to runways that may not be permitted now due to obstructions or terrain. These approaches are non-precision at this time due to the distance from the runway required for stabilizing the approach

-precision - SARPS for the GNSS precision approach have been completed. SBAS and GBAS support GNSS precision approaches to what is CAT I minimums; For CAT II or CAT III, GBAS is required. Each level of the approach approach will have a lower RNP associated with it.

* Optional

Modernization Options

Four options for modernization are detailed. Except for option 1, the options meet the technical requirements.

Option 1

This option represents the lowest level of technology implementation, representing low-cost solutions that might be suggested without regard for the overall system performance. It involves maintenance of the existing system, along with certain minor no- or low-cost improvements. By failing to effectively improve the national infrastructure, this option fails in to provide a sole means of navigation, as established for phase III of the navigation requirements established in this report. Consequently, this option is technically inadequate.

		Technology	Action
Communications	1	VHF	Replace 12 transmitters/receivers @ Maiquetía
	2	VHF-ER	Install units at Esmeralda and Canaima
	3	VSAT	Install
	4	HF	Maintain for oceanic coverage
	5	AFTN	Replace each AFTN unit with AMHS
	6	ATN	Install with sub-network interfaces starting 2007-2008
	7	REDDIG	Implement phase II and III
Navigation	8	GNSS/GPS	Institute institutional for approval and implementation
	9	GNSS-NPA	Develop procedures for Barcelona, Barquisimeto, Maiquetía, Maracaibo, Margarita, Puerto Cabello, Paraguana, Maturin, Caracas, Santo Domingo, Coro and two military airports of Venezuela's choice
	10	APV-1	Develop procedures for Barcelona, Barquisimeto, Maiquetía, Maracaibo, Margarita, Puerto Cabello and Paraguana, Maturin
	11	VOR/DME	Maintain; Partial decommission after L5 becomes operational
	12	NDB	Decommission
	13	ILS	Maintain

Surveillance	14	Radar	Maintain
ATM	15	FDEP	Install at Barcelona, Barquisimeto, Maiquetía, Maracaibo, Margarita, Puerto Cabello, Paraguaya, Maturin and two military airports
	16	SMA	Install @ Maiquetía
	17	RNAV	Establish internal RNAV routes to major city pairs
	18	RNAV	Collaborate with GREPECAS to establish more international RNAV routes
	19	RVSM	Implement
	20	Letters of Agreement	Develop to address GNSS and improved VHF frequency coverage

Option 2

Option 2 provides slightly higher levels of technology through the implementation of SBAS, overhaul of the VHF system and a lower scale ADS system. The result is a system that, while involving lower levels of technological implementation, nevertheless provides a sole means capability that Option 2 fails to provide.

Key: Grey is carried from Option 1, Hatched is not carried from Option 1, White is new to Option 2

		Technology	Action
Communications	1	VHF	Replace 12 transmitters/receivers @ Maiquetia
	2	VHF-ER	Install units at Esmeralda and Canaima
	3	VHF	Replace all platforms over 20 years
	4	VSAT	Install
		HF	Maintain for oceanic coverage
	5	AMSS	Install for oceanic coverage
	6	VDL Mode 2	Implement for ADS-A coverage areas
	7	AFTN	Replace each AFTN unit with AMHS
	8	ATN	Install with sub-network interfaces starting 2007-2008
	9	REDDIG	Implement phase II and III

Navigation	10	GNSS/GPS	Institute institutional for approval and implementation
	11	GNSS/SBAS	Install
	12	VOR/DME	Maintain; Partial decommission after L5 becomes operational
	13	NDB	Decommission
		ILS	Maintain
	14	ILS	Decommission after SBAS maturation
	15	GNSS-NPA	Develop procedures for Barcelona, Barquisimeto, Maiquetía, Maracaibo, Margarita, Puerto Cabello, Paraguana, Maturin, Caracas, Santo Domingo, Coro and two military airports of Venezuela's choice
	16	APV-1	Develop procedures for Barcelona, Barquisimeto, Maiquetía, Maracaibo, Margarita, Puerto Cabello and Paraguana, Maturin
	17	APV-2	Develop procedures for Barcelona, Barquisimeto, Maiquetía, Maracaibo, Margarita, Puerto Cabello and Paraguana, Maturin
	18	GNSS Precision Approach	Develop at Barcelona, Barquisimeto, Maiquetía, Maracaibo, Margarita, Puerto Cabello and Paraguaya
Surveillance	19	Radar	Maintain
	20	ADS-A	Install and implement in Central & Southern Venezuela (Esmarelda & Cainama)
ATM	21	FDEP	Install at Barcelona, Barquisimeto, Maiquetía, Maracaibo, Margarita, Puerto Cabello, Paraguaya, Maturin and two military airports
	22	SMA	Install @ Maiquetía
	23	Stored Flight Plan	Implement
	24	RNAV	Establish internal RNAV routes to major city pairs
	25	RNAV	Decommission internal routes ≤ FL 230
	26	RNAV	Collaborate with GREPECAS to establish more international RNAV routes
	27	RVSM	Implement
	28	SIDs & STARs	Develop at Barcelona, Barquisimeto, Maiquetía, Maracaibo, Margarita, Puerto Cabello and Paraguaya
	29	Letters of agreement	Issue to address use of SBAS, improved VHF frequency coverage, ADS, RNAV routes, reduced separation standards and transfer of communication points

Option 3

Option 3 meets the capabilities of the Option 2 system, but provides the technological and safety advantages of digital communication, upgrades in radar and the integration of air traffic management data.

Key: Grey is carried from Options 1 & 2, Hatched is not carried from Option 1, White is new to Option 2

		Technology	Action
Communications	1	VHF	Replace 12 transmitters/receivers @ Maiquetia
	2	VHF-ER	Install units at Esmeralda and Canaima
	3	VHF	Replace all platforms over 20 years
	4	VSAT	Install
		HF	Maintain for oceanic coverage
	5	AMSS	Install for oceanic coverage
	6	VDL Mode 2	Implement for ADS-A coverage areas
	7	AFTN	Replace each AFTN unit with AMHS
	8	ATN	Install with sub-network interfaces starting 2007-2008
	9	REDDIG	Implement phase II and III
	10	CPDLC	Install at Esmeralda, Canaima, Maracaibo, Valencia, Puerto La Cruz and Cuidad Guyana
	11	PDC	Install at Barcelona, Barquisimeto, Maiquetia, Maracaibo
	12	D-ATIS	Install at Barcelona, Barquisimeto, Maiquetia, Maracaibo.
Navigation	13	GNSS/GPS	Institute institutional for approval and implementation
	14	GNSS/SBAS	Install
	15	VOR/DME	Maintain; Partial decommission after L5 becomes operational
	16	NDB	Decommission
		ILS	Maintain
	17	ILS	Decommission after SBAS maturation

	18	GNSS-NPA	Develop procedures for Barcelona, Barquisimeto, Maiquetia, Maracaibo, Margarita, Puerto Cabello, Paraguana, Maturin, Caracas, Santo Domingo, Coro and two military airports of Venezuela's choice
	19	APV-1	Develop procedures for Barcelona, Barquisimeto, Maiquetia, Maracaibo, Margarita, Puerto Cabello, Paraguana and Maturin
	20	APV-2	Develop procedures for Barcelona, Barquisimeto, Maiquetia, Maracaibo, Margarita, Puerto Cabello, Paraguana and Maturin
	21	GNSS Precision Approach	Develop at Barcelona, Barquisimeto, Maiquetia, Maracaibo, Margarita, Puerto Cabello and Paraguaya
Surveillance		Radar	Maintain
	22	Radar	Upgrade (or replace) 4 systems to ASR-11 or ASR-12
	23	ADS-A	Install and implement in Central & Southern Venezuela (Esmarelda & Cainama)
	24	Position Reports	Continue where applicable
		FDEP	Install at Barcelona, Barquisimeto, Maiquetia, Maracaibo, Margarita, Puerto Cabello, Paraguaya, Maturin and two military airports
ATM	25	ATM System	Install with 14 I/O devices at busiest civil and military facilities
	26	SMA	Install @ Maiquetia
	27	A-SMGCS	Install at MQI
	28	Stored Flight Plan	Implement
	29	RNAV	Establish internal RNAV routes to major city pairs
	30	RNAV	Decommission internal routes ≤ FL 230
		RNAV	Assign RNP levels for routes and airspace
	31	RNAV	Collaborate with GREPECAS to establish more international RNAV routes
	32	RVSM	Implement
	33	SIDs & STARs	Develop at Barcelona, Barquisimeto, Maiquetia, Maracaibo, Margarita, Puerto Cabello and Paraguaya
	34	Letters of agreement	Issue to address use of SBAS, improved VHF frequency coverage, ADS. Include RNAV routes, reduced separation standards, transfer of communication points, etc.

Option 4

Option 4 provides the highest level of technology implementation of all options. This brings a fuller realization of CNS/ATM through combined SBAS and GBAS implementation, fully scaleable upgrade of communications systems to standards which permit the companion use of ADS-B, and fuller data integration through CTAS.

Key: Grey is carried from Options 1, 2 & 3 Hatched is not carried from previous options, White is new to Option 3

		Technology	Action
Communications	1	VHF	Replace 12 transmitters/receivers @ Maiquetia
	2	VHF-ER	Install units at Esmeralda and Canaima
	3	VHF	Replace all platforms over 20 years
	4	VSAT	Install
		HF	Maintain for oceanic coverage
	5	AMSS	Install for oceanic coverage
	6	VDL Mode 2	Implement for ADS-A coverage areas
	7	AFTN	Replace each AFTN unit with AMHS
	8	ATN	Install with sub-network interfaces starting 2007-2008
	9	CPDLC	Install at Esmeralda, Canaima, Maracaibo, Valencia, Puerto La Cruz and Cuidad Guyana
	10	AOA & UAT Datalink	Implement for use with ADS-B
	11	REDDIG	Implement phase II and III
	12	PDC	Install at Barcelona, Barquisimeto, Maiquetia, Maracaibo
	13	D-ATIS	Install at four airports
Navigation	14	GNSS/GPS	Institute institutional for approval and implementation
	15	GNSS/SBAS/GRAS	Install
	16	VOR/DME	Maintain; Partial decommission after L5 becomes operational
	17	NDB	Decommission
	18	ILS	Decommission after SBAS maturation

	19	GBAS	Implement at Maiquetia
	20	GNSS-NPA	Develop procedures for Barcelona, Barquisimeto, Maiquetia, Maracaibo, Margarita, Puerto Cabello, Paraguana, Maturin, Caracas, Santo Domingo, Coro and two military airports of Venezuela's choice
	21	APV-1	Develop procedures for Barcelona, Barquisimeto, Maiquetia, Maracaibo, Margarita, Puerto Cabello and Paraguana, Maturin
	22	APV-2	Develop procedures for Barcelona, Barquisimeto, Maiquetia, Maracaibo, Margarita, Puerto Cabello and Paraguana, Maturin
	23	GNSS Precision Approach	Develop at Barcelona, Barquisimeto, Maiquetia, Maracaibo, Margarita, Puerto Cabello and Paraguaya
Surveillance		Radar	Maintain
	24	Radar	Upgrade (or replace) 4 systems to ASR-11 or ASR-12
	25	ADS-A	Install and implement in Central & Southern Venezuela (Esmarelda & Cainama)
	26	ADS-B Surface Surveillance	Install at Maiquetia, Barcelona and Maracaibo
	27	Position Reports	Continue where applicable
ATM		FDSP	Install at Barcelona, Barquisimeto, Maiquetia, Maracaibo, Margarita, Puerto Cabello, Paraguaya, Maturin and two military airports
	28	ATM System	Install with 14 I/O devices at busiest civil and military facilities
	29	SMA	Install @ Maiquetia
	30	A-SMGCS	Install at MQI
	31	Stored Flight Plan	Implement
	32	CTAS	Implement
	33	RNAV	Establish internal RNAV routes to major city pairs
	34	RNAV	Decommission internal routes ≤ FL 230
		RNAV	Assign RNP levels for routes and airspace
	35	RNAV	Collaborate with GREPECAS to establish more international RNAV routes
	36	RVSM	Implement
	37	SIDs & STARs	Develop at Barcelona, Barquisimeto, Maiquetia, Maracaibo, Margarita, Puerto Cabello and Paraguaya
	38	Letters of agreement	Issue to address use of SBAS, improved VHF frequency coverage, ADS, Include RNAV routes, reduced separation standards, transfer of communication points, etc.

Cost Benefit Analysis of Modernization Options

In analyzing the economics of a preferred CNS/ATM option, the equipment costs of a more expensive option can be accepted as being saved if the required system performance is delivered. Therefore, the cost of implementing the cheaper option is subtracted from the cost of the more expensive option to arrive at the "net benefit" for the less expensive option. Of course, all additional operating costs associated with delivering the same level of service to enable the same benefits to be realized by aircraft operators and service providers during the same period of time need to be accounted for in each scenario.

The cost-benefit analysis, however, cannot capture the risks associated with cutting edge systems. Opting to become the technology leader in certain new developmental areas may have advantages on paper—but cost models cannot capture the consequence if users fail to equip, if developmental systems fail to meet desired expectations, or if regionally a different approach is adopted by Venezuela's neighbors.

Additionally, a financial analysis cannot effectively address non-financial factors that may have significant weight in acquisition systems. This is particularly true in aviation equipment, where the value of improving something so intangible as "safety" may outweigh increased cost.

Ultimately however, most system acquisition decisions are financial, since performance decisions are established with the determination of minimum requirements and the identification of systems that meet those requirements. As a financial decision, system acquisition is also a time sensitive concern. The present value concept (a means of capturing the time value of money) helps provide a means for analyzing each option's stream of net benefits over the years. Each stream reflects that scenario's distinct investment profile. For example, very large benefits and low costs (or high net benefits) arriving early from one option will bring a higher net present value than another option that starts with an initial no-benefit no-cost period and later brings a sustained level of net benefits.

Methodology

Overall, the analysis uses ICAO's cost-benefit analysis methodology by applying it specifically to different implementation. This allowed the team to evaluate the available alternate navigational technologies. In doing this, the net present value concept is used with the appropriate discount rate (ICAO methodology) to meet the objectives set out for the analysis.

The net present value approach requires the projection of the future costs and benefits associated with the implementation of satellite-based systems. Implementing GNSS will also require service providers to purchase and operate numerous equipment and systems under each technology option. Apart from equipment some services from third parties may need to be acquired, such as telecommunication services.

All the future costs of equipment and services required to maintain the current system are treated as benefits of implementing the new system as these foregone costs are in fact, savings, generated by implementing the new system.

Costs of upgrading or re-equipping those infrastructures that are near the end of their life but are needed until the new system is in place are treated as transition costs related to each technology implementation option. In addition to better separation en-route, time and efficiency related savings are expected also due to improved approach and terminal operations. These benefits are estimated, very approximately, separately as a fraction of the en-route flight time in Venezuela and the relevant terminal and approach areas.

Analysis of the full system is based on five different scenarios for system implementation. Scenario 1 involves maintenance of the existing system, along with certain minor no- or low-cost improvements. By failing to effectively improve the national infrastructure, this option fails in to provide a sole means of navigation, as established for phase III of the navigation requirements established in this report. Consequently, this option is *technically inadequate and not considered in the cost-benefit analysis.*

Each proposed technology option (scenario or project case) allows for a three-phase transition from the existing ground-based navigational system. Costs and benefits of all scenarios are considered in a consistent manner. Consequently, the benefits associated with any single scenario can be compared appropriately with those from other scenarios.

Each scenario includes comparison against a base case, as prescribed by ICAO's cost benefit methodology. The base case is defined as follows:

> *Base Case: Maintaining the level of service available in the base year, with no change to equipment other than direct replacement at the end of service life. This base case system is what would be required to be maintained into the future in the absence of a transition under any of the project cases.*

Such a scenario allows no shift to CNS/ATM or any flexibility in infrastructure beyond what is used today. Savings may be realized by accounting for the avoided cost of operating and maintaining ground-based systems that would be avoided by making the transition to a newer navigational technology. This is included in the calculation of benefits for every methodology.

Cost Benefit Analysis Conclusions

Best Scenario

Each of the CNS/ATM implementation scenarios is evaluated over the course of three time phases. Each investment option is assessed and benefits described, so that the costs of each investment option is identified and aggregated. Net benefits are evaluated across the various options in present value terms, since some options provide the advantage of recovering benefits early on. Benefits from the same options might be delayed if the timing of implementing the option is not appropriate. Evaluating the accomplishment of benefits allows a determination of the most suitable technology scenario.

Overall, the analysis of the different scenarios is as follows:

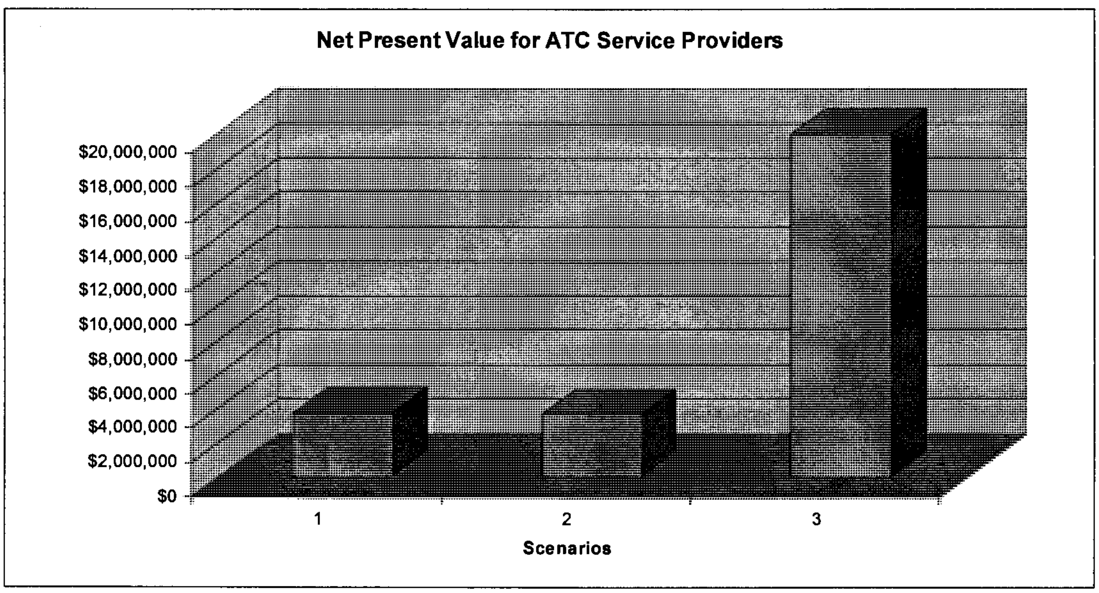
SCENARIO	TOTAL NET PRESENT VALUE	NET PRESENT VALUE FOR ATC SERVICE PROVIDERS	NET PRESENT VALUE FOR AIRCRAFT OPERATORS	NET PRESENT VALUE FOR PASSENGERS
Scenario 2	$4,880,833,448	$3,736,828	$4,659,576,250	$217,520,371
Scenario 3	$4,880,784,257	$3,687,637	$4,659,576,250	$217,520,371
Scenario 4	$4,897,048,711	**$19,952,091**	$4,659,576,250	$217,520,371

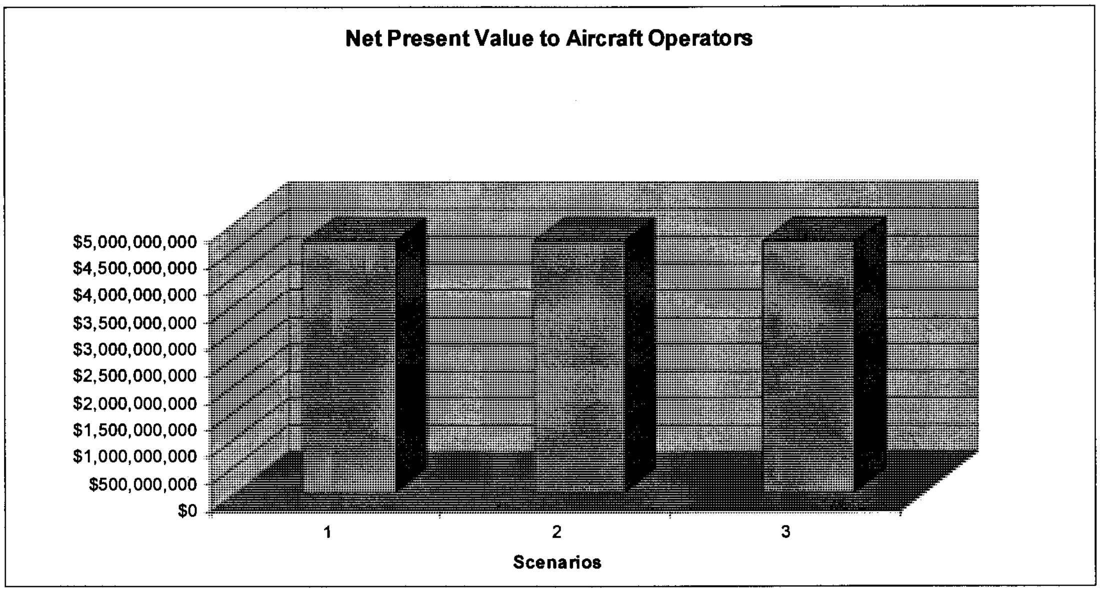
Each of these scenarios involves considerable expense for the service provider. In evaluating the situation in Venezuela, failure to effectively maintain current equipment over the past thirty years is now having a significantly negative consequence. The nation must acquire much soon to catch up to the regional standard and meet established requirements—and to benefit from the best income. Had the systems not required immediate replacement, service provider benefits would have been larger.

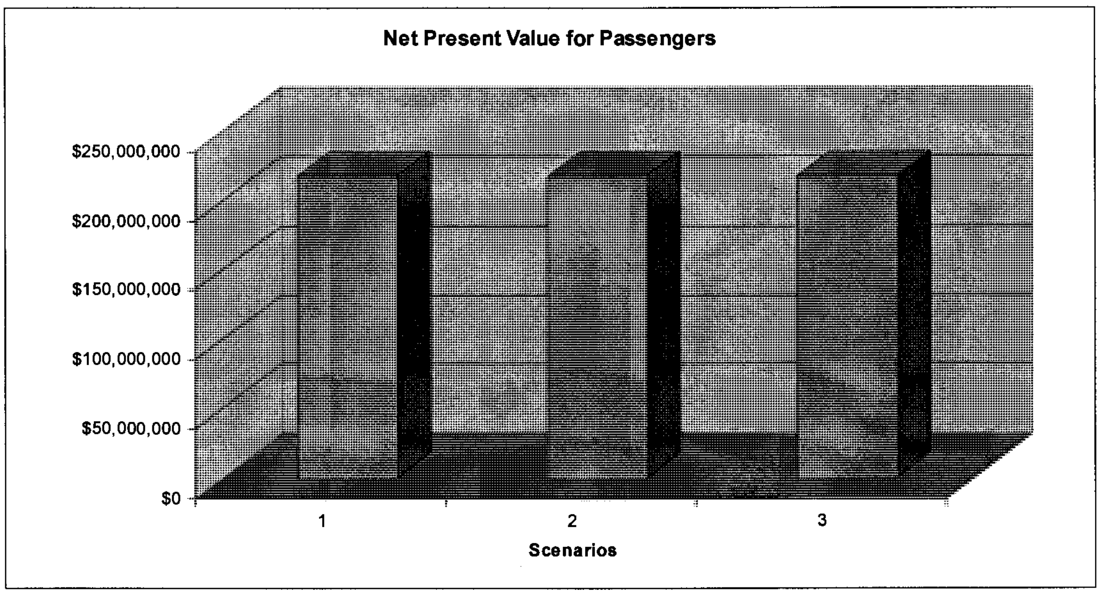
Ultimately, the best value purchase is the system that fulfills Venezuela's technical requirements for the lowest cost. There is no accountable advantage to exceeding projected requirement.

That stated, the optimal scenario for the service provider is Scenario 4—the highest technology option. It provides a relatively effective savings for the service provider (INAC), with effective benefits to users and passengers alike over the current technology. Relative advantages and disadvantages are primarily due to better acquisition sequencing and decommissioning savings. In the case of Scenario 4, it also involves investment in higher technology systems that, in real terms, ends up costing less than lower technology options.

The following diagrams show these results graphically.







Implementation

The data on these systems point out that Venezuela does not benefit from hiding from technology. Civil aviation will best benefit from a logical plan of active modernization. The result will not only be more possibilities for INAC's profitability, but also safer skies for the flying public. Safety is especially important—not only for passenger reassurance, but to support the viability of national airline industries and to attract new international flights to the nation. In turn, greater confidence in aviation has important consequences for most aspects of the Venezuelan economy, especially to attract more cargo, tourism and international business.

In acquiring a modernized aviation system, INAC needs to look beyond these system elements to establishing a more consistent and comprehensive acquisition and data administration system. During the course of this study, many data elements could not be acquired. While our staff have been able to compensate with statistics and models, running the system effectively in real-time depends on having accurate information to support financial management and system administrations. Effective systems will bring savings, through more effective invoicing, better inventory management, and the development of cash flow management procedures.

Similarly, effective acquisition management is especially important. In the past acquisitions, such as radar purchase, have been stalled due to concerns of corruption. The result has not only brought embarrassment to the civil aviation organization, it has also compromised air safety when much needed systems have not been installed. INAC must take care to ensure that systems are effectively procured, with consideration to having procedures that balance transparency with efficiency. It should follow the growing international orientation towards Best Total Value acquisition planning, so that all necessary costs (such as installation, integration and training) are scrutinized and taken into accountability. This level of diligence is necessary to ensure money is not wasted and to maximize INAC's purchasing power.

Ultimately, it is in INAC's best interest to take an effective path to modernization—and to establish the procedures and support systems necessary for making sure that implementation actually succeeds. Failing to do so will not only squander INAC's best opportunity to greater profitability, but also will increasingly put human lives in greater danger.

Project Financing

In evaluating the funding options, ISI has examined the existing revenues and costs of operating and maintaining existing Air Navigation Services (ANS) as well as the consolidated costs of operating and maintaining the international airports in Venezuela. These examinations have provided a preliminary picture of the stability of the finances of the Venezuela aviation sector.

In identifying the funding options, ISI has reviewed the available major financial statements for INAC. Together with the pro forma cash flow statement for the recommended equipment, these current statements provide an indication of the financial capability of INAC and the potential for alternative funding options.

Project Cash Flow

ISI has used INAC revenues to develop a pro forma cash flow of the recommended investments. The recommended investments include the installed equipment at each of the airports and the equipment and services outside of the airport boundaries.

Actual operating costs were not provided to the financial team for this project. As such, the team established an estimate for costs, based on actual operating costs for other civil aviation administration (scaled to Venezuela's scale of operations)

ISI has assumed that all of the investments will be fully financed with debt. Financing was calculated, based on 15 years loans with no grace period at an interest rate of 7%. If the interest rate assumption is reduced, the cash flow will be greater. If a grace period is assumed, the cash flow will be greater during the grace period and lower afterwards, since the grace periods are usually capitalized. However, the discounted cash flow will be greater with a grace period than without a grace period, assuming a constant interest rate over the 15 year period of the loan.

The pro forma cash flow statements for the periods 2003 to 2007 and 2008 to 2014 are given in the tables below for each of the options. This cash flow reflects that investments are made in periodically through the years to 2014.

Option 4 Cash Flow ($000)	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Revenues	$8,764	$9,290	$9,848	$10,438	$11,065	$11,729	$12,198	$12,930	$13,705	$14,528	$15,399	$16,323
Operating Expenses	$1,461	$2,721	$2,777	$3,059	$3,275	$3,454	$3,559	$3,584	$3,610	$3,636	$3,662	$3,689
Net Operating Revenue	$7,303	$6,569	$7,071	$7,379	$7,790	$8,275	$8,639	$9,346	$10,095	$10,892	$11,737	$12,634
Total Recommended Investment	$0	$20,422	$575	$4,270	$3,177	$2,584	$1,334	$22	$22	$22	$22	$22
Cumulative Investment		$20,422	$20,997	$25,267	$28,444	$31,028	$32,362	$32,384	$32,406	$32,428	$32,450	$32,472
Debt Service	$0	$2,242	$2,305	$2,774	$3,243	$3,527	$3,673	$3,676	$3,678	$3,680	$3,683	$3,685
Cash Flow	$7,303	$4,327	$4,765	$4,605	$4,547	$4,748	$4,966	$5,670	$6,417	$7,211	$8,054	$8,949

Recommendations

Efficiency Improvements

Regardless of the sources of funding, there are clear steps that INAC can take to improve its own institutional processes to improve access to funds.

First of all, INAC can start a process of building efficiencies to its existing system. Core short term improvements would include:

- **Airport Computerization**: At most airports, transaction reports are processed manually. A few airports have extremely antiquated (8088 processors with 5" floppy drives) computer systems for transaction reports, however, since there is no system integration, report sent from these aged system must be manually copied on receipt. Installation of low-cost PCs with modems and common commercial software at all airports could provide an initial means to improve critical corporate intelligence, not only of operations, but also of other important areas such as parts inventories.
- **Use Couriers to Ensure Invoice Receipt**: Currently, invoices are sent to users through regular postal mail. Interviews with fee collection staff indicate that some invoices never get paid because airlines deny that they ever receive their bills. Shipping invoices by couriers (requiring signature) is a means to eliminate this excuse.
- **Improved Collections**: Additionally, INAC fails to follow up on problem collection cases in a timely matter. As a result, many users (especially foreign companies) never pay their bills.

Ultimately, however, improving fee collection will require a larger scale organizational change. Venezuela stands to benefit significantly if it can ensure that "ghost flights" (flights that pass through airspace without contacting air traffic control) are accounted for, if transaction data is more efficiently processed, if charges are guaranteed and if collections are scrupulously sought. In most civil aviation administrations, this area is handed over to outside service providers. A commercial service provider can introduce necessary automation, pursue necessary legal measures in a more proactive manner, provide greater institutional integrity, and bring in a profit motive to bringing more funds to INAC.

Procurement Process Improvements

Additionally, INAC needs to modernize and improve its procurement system. Since the Ley Paraguas sets a time limit on acquisition, every effort must be made to make the institutional process of tendering and procuring happen faster and more effectively. As a contracting organization, INAC is charged with a public trust

It is not really feasible to try to change the loan rules required by Congress. On the other hand, INAC can improve its own procurement process. In particular, proactive efforts to give the process efficiency, integrity and transparency are necessary to ensure that INAC can use the debt authorization that it works so hard to attain.

The business case for this is clear: when the procurement process stalls or fails, INAC does not get to acquire the equipment it needs to function. That ultimately hurts the system function and INAC's bottom line. Fortunately, INAC does not have a problem with staff trustworthiness. INAC staff is highly dedicated and works with integrity. However, these people do need better procedures.

Working within the legal structure of Venezuelan law, INAC can make its procurement system work better. INAC must give all bidders an equal chance at winning business by awarding to the lowest-priced vendor that meets the government's minimum needs. Part of this is maintaining the highest standards for integrity, so that delaying irregularities do not occur. Procurement officials need a guide to what is permissible and what is illegal behavior, so INAC must develop a standard of conduct applicable to all relevant staff—whether internal or contracted outside the house.

These rules must pay particular attention to areas where proprietary equipment is involved and the full cost required to getting that equipment functioning and certified. Depending on what is purchased, actual implementation of a system may require unique side services or equipment, such as installation, integration, spare parts, training and automation. For example, it is not in INAC's best business interest to get a cheap ILS if it has to later pay uncompetitive prices to install the system's proprietary monitor and a tower feed.

Accounting System Improvements

Previously, as an integrated component of MINFRA, civil aviation functioned off a government budget and had little consequential control or management of its own funds. Now, as a semi-autonomous organization, INAC has an opportunity to leverage financial control into profitability. To do this, the organization must implement more accounting reporting requirements, thus providing the data and corporate intelligence to inform top management on how it can improve its cash flow management.

Throughout the course of this study, our team tried to acquire data on the operational cost of running civil aviation. We are not sure if this information was not provided because of its sensitive nature—or if it isn't maintained at all. This compromised the validity of the financing analysis, since the team had to model replacement figures without reference to the costs that INAC actually incurs.

Funding Options

ISI has investigated the possibility of funding from a number of sources including the multinational financial institutions, commercial investment banks, government financial agencies, and potential suppliers. Financing is available. However, the rate and terms and conditions vary considerably.

The Venezuela Ministry of Finance may not be particularly enamored with debt that is of a commercial character. Such debt, whether private, quasi-public, or public, will have financing costs that may be deemed too high. Subsidized loans and/or grants are undoubtedly much more attractive to MINFRA and the Ministry of Finance. However, this does not mean that financing from the agencies such as the U.S. Export-Import Bank at commercial rates will not work. A financing package that might include an insurance package (for example, from the World Bank, International Development Bank (IDB) or the Overseas Private Investment Corporation (OPIC)), supplier credits, an aggressive grace period, government grants or technical assistance for training or installation, and equipment discounts on maintenance and/or installation can effectively reduce the financing costs to a point that is lower than the costs of a conventional package at a very low interest rate.

Lacking any financial data on either INAC or MINFRA, our team was unable to provide substantiation of the financial stability of the organizations. As such, external debt will require either a sovereign guarantee on the part of the Venezuelan Government or the escrow of aviation fees (in hard currency) in an offshore institution for the payment of interest and the amortization of the debt.(or both). Of course, the IDB might provide some co-financing or insurance. But this would also require a more thorough acquisition of the financial data in the aviation sector.

If INAC is privatized or corporatized, an option for the installation of the equipment is to consider the purchase and installation as a specific function of the new entity. As such, revenues that are generated by the use of the equipment can be used directly to operate and maintain the equipment and to amortize the debt.

Transition Plan

Objective

The objective of this plan is to provide a Communications, Navigation, Surveillance, and Air Traffic Management (CNS/ATM) implementation plan that represents Venezuela's long-term strategy for the transition from a terrestrial-based air navigation system to one that is predominately satellite-based. This plan has been developed from the "Minimum Domestic ATM Equipment Requirements" documented in the Task 3 working paper and prepared so as to parallel the CAR/SAM (Caribbean/South American) Regional CNS/ATM plan prepared by GREPECAS (Caribbean-South America Planning and Implementation Regional Group), a formal working group of the CAR/SAM Region.

Background

In an effort to assists the states in CNS/ATM implementation, ICAO developed a Global CNS/ATM Plan. In this plan ICAO indicated that CNS/ATM should be implemented in concert with regional planning groups, but ultimately, CNS/ATM implementation is each state's responsibility. Acting on the ICAO concept, the CAR/SAM Region has developed, through their formal planning group, GREPECAS, a regional CNS/ATM plan for all of their member states and for the states to use as a guideline to develop their own CNS/ATM implementation plans. We have developed this plan in parallel to the GREPECAS plan so that Venezuela's plan is a coordinated effort with GREPECAS to ensure a smooth and successful transition.

This plan was developed and updated with information and guidance obtained from several sources including:

- ICAO Panel Groups (GNSSP)
- ICAO Global Plan for CNS/ATM Implementation (DOC 9750)
- ICAO CNS/ATM Taskforce
- GNSS Manual (Final Version 2/1/02)
- CAR/SAM Documents
    - The CAR/SAM Regional CNS/ATM Implementation Plan
    - Transition to CNS/ATM in the CAR/SAM Region (Lima, Peru, May, 2001)
    - Informal Meeting CNS/ATM Working Group (Bogotá, Colombia, Oct. 2001)

National CNS/ATM Committee

This plan cannot be implemented by one office or one organization, but will require a diversity of talents. Therefore, we recommend that Venezuela establish a National CNS/ATM Committee to be the focal point for concept planning and developing CNS/ATM requirements, and to provide oversight in the implementation process.

Objectives of the National CNS/ATM Committee

The objectives of the CNS/ATM committee could be, but not limited to, the following initiatives:

- Serve as the focal point for planning and coordination for the implementation of satellite-based CNS/ATM systems in Venezuela;
- Ensure that this plan meets both system user and service provider requirements;
- Review the results of worldwide CNS/ATM trials and demonstrations and validate those results to determine their relevance to Venezuela's needs;
- Ensure that required international coordination is effected throughout the transition to a CNS/ATM environment;
- Recommend transition priorities; and
- Review and update this implementation plan periodically.

Limitations

It should be noted at the beginning of this plan the limitations that Venezuela may experience during this transition due to the ICAO structure. Venezuela is a member state of GREPECAS and like other member states of GREPECAS are members of a larger ICAO body, the Caribbean/South American Region (CAR/SAM). ICAO has developed a Global CNS/ATM Plan that contracting states such as Venezuela and regional planning groups such as GREPECAS use as a guide to develop regional and state CNS/ATM implementation plans.

Therefore, any CNS/ATM implementation plan proposed by Venezuela should follow the same course as the CAR/SAM Regional Plan, particularly in regard to implementation of regional CNS/ATM initiatives such as the SBAS. With this feasibility study, Venezuela now has an idea of cost projections, equipment needed, benefits available, and how to implement this new technology. Venezuela only has to satisfy itself whereas both GREPECAS and CAR/SAM must gain approval of all member states, which could cause delay and impede any transition schedule. Therefore, it is very important that INAC and the National CNS/ATM Committee be active participants in the development and implementation of CNS/ATM by GREPECAS.

Implementations Guidelines

The following guidelines should be considered when implementing CNS/ATM. They include the main components of CNS/ATM as well as meteorology, aeronautical information services, staffing, and training.

Communications

The future aviation communications systems will be very different from the present aviation communications systems. Networks and sub-networks that use data transfer technology will characterize the future communications infrastructure. Although VHF voice will continue as the primary air-ground communications link for several years to come, it will eventually give way to data link and when that occurs, VHF voice will only be used for non-routine or emergency communications. It is expected that data link communications will be used for all routine air-ground communications in the not to distance future. However, it is more important to provide communications within one's own airspace first. The following guidelines are based on the proposed communications objectives outlined in this plan.

1) Communications should be improved and expanded in those areas where traffic levels require two-way communications. Resources should not be expended providing communications in areas where there is insufficient traffic to warrant the expense.

2) Controller-Pilot Data Link Communications (CPDLC) should be implemented only in those areas where a benefit can be provided, and only if it is cost beneficial.

3) Data link should be used for future routine communications between air traffic services (ATS) units and properly equipped aircraft. The initial application of Pre-departure Clearances (PDC) and Airport Terminal Information Service (ATIS) via VDL Mode 2 should set the tone and provide experience for future use of data link for routine messages.

4) Several different data links are being considered for various purposes for the transmission of air traffic control data. No decision has been reached regarding the most definitive data link to use for each initiative; although data transfer protocols and message types should be harmonized. However, Venezuela should consider VDL Mode 2 as its preferred link.

5) The Aeronautical Telecommunications Network (ATN) will provide for the interchange of digital packets between end-users over dissimilar air-ground and ground-ground communications links. The Aeronautical Message Handling Service (AMHS) will be the first sub-network of the ATN for operational use.

Navigation

Guidelines for the transition to the future air navigation system should encourage early equipage by users through the earliest possible accrual of system benefits. During the transition period dual equipage, both airborne and ground, will be necessary in order to ensure the reliability and availability of the new system; however, these guidelines are aimed at minimizing this period to the fullest extent possible.

1) The Global Navigation Satellite System (GNSS) using the Global Positioning System (GPS) should be initially approved for supplemental and/or primary means for domestic en route, terminal and non-precision approach. When GNSS is augmented by the Space-based Augmentation System (SBAS) or the Ground Regional Augmentation System (GRAS)), it should be approved as a sole means navigation system for all phases of flight.

2) The ground infrastructure for the current mandated navigation system must remain available during the transition period. This provides a measure of system redundancy and allows users an early glimpse of the tangible benefits captured.

3) States, ATS providers, and/or regions should consider segregating traffic according to navigation capability (GNSS equipped/non-equipped) and granting preferred routes to aircraft with more advanced navigation capability. This will speed up the equipage process.

4) States and/or regions should coordinate with each other to ensure that separation standards and procedures for appropriately equipped aircraft are introduced simultaneously in each FIR where major traffic flows will occur.

5) States should ensure progressive introduction of area navigation (RNAV) capability to meet required navigation performance (RNP) criteria. RNP must be combined with communications and surveillance capabilities to determine separation standards.

6) GNSS precision approaches using both the SBAS and GRAS will eventually phase out both the current instrument landing system (ILS) and the micro-landing system (MLS) for precision approach and landing. GBAS may become the GNSS augmentation of choice in many areas of the world to replace ILS/MLS; however, States should consider the abilities of SBAS to meet existing Cat I precision approach requirements. The GRAS can be configured to provide GBAS capabilities.

7) Non-directional radio beacons (NDB) and VHF Omni-directional ranges/distance measuring equipment (VOR/DME) should be withdrawn progressively and only near the end of the transition. A limited, ground-base navigation system should remain as a possible back-up should satellite navigation fail.

Surveillance

Radar is and will continue to be the surveillance system of choice for air traffic control. Automatic Dependent Surveillance (ADS) will enhance radar, and in many places where radar is not available, e.g., mountains, jungles, oceanic and remote areas, ADS may be the primary surveillance system. The transition to an ADS environment can begin with a simple system that can be easily expanded and enhanced as the provider desires. Although not recommended as an early CNS/ATM initiative, INAC should consider ADS as a surveillance tool for central and southeastern Venezuela. The following guidelines should apply:

1) INAC should begin to develop operational procedures and guidelines in accordance with ICAO Standards and Recommended Practices (SARPs) for the implementation of ADS within airspace under their control by 2006.

2) INAC should coordinate with GREPECAS to ensure that where ADS is to be introduced, it is fully coordinated with adjacent facilities, and where surveillance services are provided within an adjacent FIR, that those systems are compatible and that data protocols permit the sharing of surveillance information.

3) During the transition to ADS, suitably equipped aircraft should be given preference over non-equipped aircraft for preferred routes and airspace.

4) Upcoming procurements for radar should be specified to take include all proprietary subsystems and services, so that INAC does not find itself forced into an anti-competitive system when these requirements are realized. This includes the foundation primary system, the secondary element, automation, spares and installation.

Air Traffic Management

The following guidelines are recommended for the implementation of air traffic management objectives for CNS/ATM implementation. INAC should:

1) Maintain or increase the present levels of safety;
2) Increase system capacity and full utilization of capacity resources as required to meet traffic demands and to allow for reduce lateral route separation (RLRS);
3) Provide dynamic accommodations of user-preferred, three- or four-dimensional flight trajectories;
4) Accommodate the full range of aircraft types and airborne capabilities;
5) Improve the dissemination of aeronautical information through an improved AIS capability to the users such as weather conditions, traffic situation, and availability of facilities; this dissemination can take place through en route VHF data link (VDL) or HF Data Link (HFDL);
6) Improve navigation and landing capabilities to support advanced approach and departure procedures;
7) Increase user involvement in INAC decision making; Collaboration is an important part of CNS/ATM;
8) Create to the extent possible a single continuum of airspace, where international boundaries are transparent to users;
9) Organize the airspace in accordance with ATM provisions and procedures; and improve ATS strategic planning to minimize future aircraft conflict and conflict-resolution maneuvering by the ATS system.
10) Develop the air traffic procedures that permit and authorize the benefits that are potentially available from a CNS/ATM environment while meeting or exceeding previous and/or recommend target levels of safety.

Meteorology

Even though not directly related to CNS/ATM, meteorology is an important function in the successful implementation of CNS/ATM. The provision of weather services has primarily been supported more at the local and regional level, but with the improvement in meteorological technology and the dissemination vehicles now available such as the world wide ATN, a successful implementation of CNS/ATM can not be implemented without the implementation of new weather tools. These weather tools include WAFS (world area forecast system) and OPMET (operational meteorology) information and new weather reporting systems such as AWOS (Automated Weather Observing System) and ASOS (Automatic Surface Observation system)

Venezuela needs to be aware of the latest in meteorology technology and begin their planning to acquire this technology. This technology must meet global, national, and regional requirements. Some of this technology has not been fully defined or developed; however, meteorological systems will be required to support the following:

- Uplink of upper winds, temperatures, digital airport traffic information service, runway information, and SIGWX forecasts to aircraft, air traffic control, and dispatchers;
- Expansion of the three-satellite broadcasts to exchange global OPMET information:
- Downlink of meteorological information direct from aircraft for dissemination along a global network (en route data link);
- Meteorological sensors to provide runway information which could increase runway capacity; and
- Harmonization of Aeronautical Information Service and Meteorological Information to support pre-flight briefings.

Aeronautical Information Service (AIS)

The major objective of AIS is to ensure the flow of information necessary for the safety, regularity, and efficiency of international aviation. States are responsible for providing this information and for the quality and accuracy of the information provided. With the advent of CNS/ATM, that information has become data dependent. ICAO guidelines indicate that as of January, 1998, States must have taken steps to introduce an organized system that provided assurance and confidence to the aeronautical community as to the accuracy, quality, and timeliness of aeronautical information.

With the implementation of CNS/ATM new requirements have emerged. Many of these new requirements still must be defined, but the general view is that AIS must provide information for guidance of an aircraft for a gate-to-gate (departure to destination) operation. One of these new requirements will be the addition of electronic maps and charts, and the capability to transmit these maps and charts electronically. Development of AIS systems will be required for the following areas:

- Implementation of the WGS-84 datum;
- Extension of the broadcast of AIS information through satellites to exchange data base information;
- The quality of production, maintenance, and distribution of AIS information; and
- Harmonization of AIS, MET, and flight plan processing to support automated pilot briefings.

Human Resources (Staffing and Training)

The ICAO goal of seamless worldwide navigation can only be achieved with a quality trained workforce. A quality trained workforce is only possible if there are sufficient personnel to staff positions of operations while this training is being administered. In a recent ICAO study concerning training, it was determined that re-training will be required for a number of disciplines with emphasis on automation, data communications, and computers. INAC must consider from the start whether they have sufficient controllers and technicians to complete the implementation. If not, training classes should begin immediately.

Institutional

As a component of its relatively recent definition of civil aviation administration as a semi autonomous organization, INAC needs to revise several elements of its institutional composition. Three core areas, accounting, procurement and collections, presently hinder institutional profitability and execution of INAC's technical goals. To become a viable independent organization, INAC managers need to have better financial data to make decisions, purchases have to occur faster and without interruption, and the agency needs to realize every fee it is due in a more timely manner. The following areas need action:

- Establish a study to look at current accounting systems and to define new reporting requirements and monitoring systems
- Draft a procurement manual establishing standard rules for conduct of procurements and acquisitions. INAC would be advised to engage existing procurement and contracts staff, encouraging them to offer suggestions for making the system more streamlined and to improve integrity. Resulting rules should be applied to all staff involved in product and service acquisitions, whether INAC staff, vendors or independent consultants.
- Tender fee collection and administration activities to an independent organization.

CNS/ATM Implementation

General

This CNS/ATM implementation plan closely follows the initiatives outlines in Option Four of the four options developed for this project. Option Four is considered the best option due to the multiple benefits that are offered and because it is the most cost productive based on the cost benefit analysis. This plan has been developed for a three-phased implementation that permits each phase to build on the previous phase and is tailored to allow flexibility in the implementation time lines. Implementing CNS/ATM in phases serves several purposes. It allows for maturation and experience to be gained on one level before proceeding to the next. It provides Venezuela the opportunity to implement CNS/ATM on a schedule determined by INAC and the CNS/ATM committee. Finally, phased implementation does not require all elements of CNS/ATM to be operational and in place at the same time, thereby easing a potential financial burden on Venezuela and the system users.

The CNS/ATM implementation will take several years, allowing Venezuela time to build on each segment of implementation. The timelines and milestones for implementation are outlined in Appendix I. This plan is developed based on known technology; however, it is flexible enough to allow for the integration of new technologies as they become available.

INAC is responsible for the implementation of CNS/ATM initiatives. The CNS/ATM committee sets the requirements and INAC is responsible for satisfying those requirements. However, in a collaborative approach, INAC should do nothing in a vacuum. Once INAC receives the requirements from the CNS/ATM committee, INAC should coordinate with the committee on how they intend to satisfy those requirements. They should allow the committee to provide comments and INAC should review those comments in light of a teamwork approach. Arbitrary satisfying of requirements should be avoided at all costs. We have adjusted the schedule somewhat so that Phase I of this plan begins in January, 2005. Nevertheless, pre-implementation should start as soon as possible. Venezuela should use the time prior to 2005 to review and tailor its transition schedules and to prepare for the transition.

There are no specific dates that delineate the end of one phase and the beginning of another. The phases are simply a way of bundling initiatives together so they can be completed in an incremental manner and arranged so that each phase builds on the initiatives completed in the previous phase. For example, the development of RNAV approaches builds on the approval of GNSS as a supplemental means of flight. The implementation of data link builds on the improvements in communications. Do not be concerned if one phase overlaps another, in fact the schedule is designed for overlap. The initiatives are also arranged based on technology and could be delayed due to technology development.

The transition schedule for this plan is attached as Appendix I. The timeframes are indicated by years through 2014. The time line starts in the year the initiative should be started and ends in the year that the initiative should be completed. When the time line starts and ends in the same year, then the initiative should be started and completed in the same year. The schedule is broken down into three phases with the four CNS/ATM components (Communications, Navigation, Surveillance and Air Traffic Management) indicated in each phase. There are several initiatives indicated under each component in each phase. Each initiative in the schedule is identified by a black dot. Those initiatives not directly related to the four components are aligned under the component that is closest associated with it. The dotted lines that follow the time lines indicate that the demonstration and/or work has been completed, and the benefits for that initiative are being offered on a full time basis. There is no problem in starting an initiative earlier that projected.

Implementation Strategy

Communications

This plan calls for VHF communications to be extended to cover the entire FIR. Several situations have occurred when northbound aircraft entered the Venezuelan FIR before the controllers knew it due to a lack of communications. This extension of communications will also help to eliminate the altering of courses due to weather and turbulence that goes unreported in the southern area. We recommend the installation of at least 2 VHF ER (extended range) platforms; one at Esmeralda and one at Canaima. These facilities should be able to cover a radius of approximately 175 NM or greater at FL 270 and above. Due to the locations and the possibility of poor telephone lines, we recommend a VSAT at each platform to transmit the communications back to the ACC at Maiquetía.

We recommend the replacement of 12 VHF units in the Maiquetía ATC facilities (ACC, Approach Control, and ATC Tower) and all VHF units that are more than 20 years old. The Maiquetía upgrade is more immediate than the others. The remaining transmitter/receiver units are not upgradeable to current or future standards; most are failing and are not being repaired in a timely manner. Additionally, some of these units have been out of service for several years. Due to the number of units that require replacing, Venezuela may want to combine the recommendations and make one buy spread out over a longer period of time. We are recommending the AMSS later in the transition for oceanic use, but HF communications should continue for oceanic coverage and should be upgraded to include data link.

We are recommending the implementation of VDL (VHF Data Link) Mode 2 as the preferred data link medium for Venezuela. VDL Mode 2 is an addressable, high speed, operational data link that features VHF data link using "Carrier Switching, Multiple Access (CSMA)" protocols, which operates at a faster baud rate of 31.5Kbps. We are also recommending the implementation of four data link initiatives that use VDL Mode 2; Pre-departure clearances (PDC); Digital Airport Terminal Information Service (D-ATIS); ADS-A, and Controller-Pilot Data Link Communications (CPDLC). Pre-departure clearances and airport terminal information services are two items where VHF data link (VDL) expedites flight information and reduces the workload of both the controller and the pilot.

Even though we recommend VDL Mode 2, INAC should be alert for the development of AOA. AOA is an ACARS use of VDL Mode 2. At present ACARS is not ATN compatible. While VDL was designed to transport ATN air-ground communications, it can also transport ACARS communications as well. In the VDL AOA architecture, the aircraft uses the ACARS air/ground protocol over the ICAO VDL Mode 2 link (Aviation VHF Link Control -AVLC) increasing the capacity over the VHF link. In the AOA architecture, aircraft use the AVLC to transport binary data over the VDL Mode 2 link to ground stations. The AVLC provides a connection to a VDL sub-network that provides the aircraft access to the ATN, thus permitting ACARS to be compatible with the ATN. AOA is an interim step towards ATN in Latin America and has tremendous potential as an efficient and economical data link.

CPDLC is also recommended in Phase III of this plan, but only if a benefit can be gained that is cost efficient. Our experience with CPDLC at this juncture is that it may not satisfy a cost benefit study and is not desirable in a high population of aircraft such as an approach control (APP) or ATC tower (ATCT). CPDLC will be a functional enhancement to the CNS/ATM system which may enhance capabilities for both en route and arrival/departure control domains. CPDLC will provide an additional means for two-way dialogue between controllers and pilots for ATC clearances, requests, instructions, and pilot reports. Information exchange between the air and the ground will become more robust due to the added clearance and instruction delivery capabilities provided by data link communication. CPDLC will be implemented as a digital computer-to-computer communications network. The network will consist of both ground-to-ground and air-to-ground components that will provide communication services to aircraft equipped with appropriate avionics.

Navigation

The future navigation system will be characterized by the Global Navigation Satellite System (GNSS) and its augmentations. At the center of GNSS will be the Satellite-based Augmentation System (SBAS), which is an augmentation of GNSS. SBAS provides a method for sole means navigation, which provides many navigational benefits from direct routes to precision approaches. SBAS provides sole means navigational services for the domestic en route phase to the CAT I precision approach phase. Aircraft must carry SBAS avionics, but need no ABAS (airborne-based augmentation system) to use SBAS.

GREPECAS has already selected the WAAS (Wide Area Augmentation System) as their SBAS. The WAAS test bed has already been established and is presently providing a WAA-based signal-in-space. Venezuela is not presently part of the current CSTB (CAR/SAM Test Bed), but needs to participate in this group to gain the technical experience it needs if it decides to offer the SBAS in 2006. Unaugmented GNSS and the ground-based navigational system (VOR/NDB/ILS) will provide the navigation capability until SBAS is certified in 2006/2007.

We have provided information on the Ground Regional Augmentation System (GRAS) which provides similar services as the SBAS although it is more regional than global. It could also serve Venezuela's navigational needs. Both SBAS and GRAS have their separate advantages, but basically supply the same service, although there may be cost considerations. However, the GRAS can be configured to provide CAT II or CAT III precisions approaches, whereas the SBAS can only provide CAT I precision approaches. In any event Venezuela needs to approve GNSS as a primary means of navigation as a transition to either SBAS or GRAS. GNSS non-precision approaches can be developed and implemented at three or four airports under a primary approval so both provider and user can gain GNSS approach procedure experience. These approaches are in additional to the conventional approaches already in operation. One or two SIDs and STARs can be developed for test and demonstration until an augmented system is operational.

GNSS has also provided a new type of approach: non-precision approach with vertical guidance (APV). APV-1 approaches are GNSS non-precision approaches that use an electronic glideslope provided by onboard avionics. This is a new approach and has not received final ICAO approval, but has the capability of providing approach minimums below that of conventional approaches. APV-2 approaches are GNSS non-precision approaches that use an electronic glideslope provided by on board avionics, but requires the use of SBAS for navigation to obtain the lower minimums. This is also a new approach and has not yet received final approval from ICAO, but it has the potential for approach minimums near that of present CAT I minimums. The use of this approach may invalidate a requirement for an ILS CAT I precision approach at some airports.

There is no requirement to maintain a skeleton, ground-based system; however, we recommend that Venezuela keep a VOR skeleton system for redundancy up until the GPS's L5 band become operational in 2005, which many countries are opting to do. The ILS at the major airports should be maintained until SBAS precision approaches are mature (2008) and then should be decommissioned with the exception of one or two airports to maintain redundancy for precision approaches in Venezuela.

At present Venezuela is participating with GREPECAS for RNAV routes between the USA and South America. However, Venezuela is large enough so that RNAV routes can be developed for internal use. These routes would be developed for the lower altitudes such as FL 230 and below to provide benefits for local Venezuelan aircraft. Venezuela will also implement RVSM (Reduced Vertical Separation Minima) in accordance with the GREPECAS timetable.

Surveillance

We are recommending extensive upgrading of the radar environment. Our on-site assessment revealed that Venezuela's radars are ageing and lacking the advance

automation that is common to advanced radar. The AIP indicates that in the secondary radar environment separation could be between a minimum of 10 NM and a maximum of 100 NM depending on the use of DME distances to validate the standard being used. Three approach controls that have radar, Barquisimento, Maracaibo and Margarita, provide only radar information and services within their jurisdiction, but do not provide radar control (separation). It appears that radar is not being used to its fullest potential, which could be a result of radar not being certified (due to age or lack of spare parts). We are recommending that these radars be replaced with modern MSSR radars.

The ASR-11 radar system is on the cutting edge of solid-state technology. It is a modular, fully solid-state, primary radar system that incorporates the latest technology in airport surveillance radar systems with secondary coverage out to 250 NM. It provides very accurate aircraft position information under the most extreme conditions of weather, ground clutter, natural and man-made interference, and ground vehicular traffic. It is equipped with a separate weather-processing channel and can define the weather in six different levels of intensity.

We have also recommended that surveillance be enhanced with ADS-A for central and southeastern Venezuela near the Brazilian border. Surveillance through ADS-A is provided by using positioning information of the aircraft derived from GNSS that is transmitted to a ground receiver via an appropriate data link and then displayed on a visual display. VDL Mode 2 is the choice for ADS-A, with HFDL used as backup. ADS-A can be used as a gap-filler for surveillance in those areas that eventually will require radar until radar becomes available and/or affordable.

We are also are recommending ADS-B in Phase II for surface surveillance at MQI. ADS-B requires a broadcast link and several links are being examined. The most logical choice appears to be Mode S. It appears to be the least expensive and aircraft are beginning to equip with the Mode S extended squinter upgrade. Other links that are being demonstrated are UAT, AOA, and VDL Mode 4. Both have ADS-B potential but neither has approved standards. ADS-B has applications for surface or ground surveillance and for surveillance within the terminal area such as departure surveillance.

Air Traffic Management

We are recommending that Venezuela provide some type of automatic flight data processing. This can be accomplished with a Flight Data Processor (FDP) or Air Traffic Management System (ATMS). Both systems will interface with the AFTN, utilize

AMHS to process flight data and flight plans, provides flight progress strips to all ATC facilities with drops, provide intra-facility coordination, and a variety of other non-control functions. The FDP will not record the entry/exit time of all aircraft that enter and exit Venezuelan airspace and determine payment for each overflight aircraft unless those entries are made manually. The Air Traffic Management System will do all the things the FDP will do plus it will process radar data from numerous radar sites, provide more administrative-type functions and benefits, record aircraft entry and exit times automatically, and has the storage capacity to provide for a "stored flight plan" concept. However, all this comes at a higher cost. Based on the recommendation for four additional radar systems, we recommend the Air Traffic Management System. In any event, Venezuela can not continue to use the manual processing of flight data, flight plans, etc., much longer.

We are also recommending a "stored flight plan" concept. Our on-site evaluation indicated the flight data position was an extremely busy position and many problems would be resolved with an automated system. The stored flight plan program would be maintained by INAC, but initiated by the users. The users who have scheduled flights on a daily basis or at least a frequent basis going to the same destination via the same routing and requesting the same altitude can participate. They simply provide this flight plan to Venezuela who will store and print this flight plan out each day two hours before flight time. If a user wants to change the flight plan, he notifies the office in charge of this program a few hours prior to the time the flight plan is printed. A change is then made. Aircraft can always requests altitude changes on frequency. The ATM system has the storage capacity to maintain a stored flight plan concept.

We are also recommending the use of Surface Manager Advisor, an automation tool, to provide for collaboration between users and providers in an airport/terminal setting at Maiquetía. In addition to SMA, we are also recommending Advance Surface Management and Guidance Control System (A-SMGCS). A-SMGCS is a lighting and signaling program which includes improved signs, signals, lighting, and markings. It has substantially reduced runway incursions at other airports, and has reduced the workload for controllers around the airport.

We are also recommending a variety of controller tools in Phase III such as CTAS (Center-Terminal Automatic Sequencing Tool), URET (User Request Evaluation Tool), and P-fast (Passive-final approach sequencing tool). These tools ease the controller's workload by using computers and radar to determine arrival rates, aircraft spacing to the final, and a host of other benefits that reduce the stress and anxiety of controllers.

Phase I (2005-2007)

Communications

Upgrade the ACC VHF communications infrastructure by installing VHF platforms (transmitters/receivers) in the southern area to comply with CAR/SAM Rec. 14/29.

This initiative will provide VHF coverage for aircraft operating between points in Venezuela and Brazil and between Venezuela and other southern South American countries. Several situations have occurred when northbound aircraft from the Manaus area were more than 150 NM in the Venezuelan FIR before the controllers knew it. This may be attributed to ground-ground communications, but if there were VHF communications within the FIR as recommended by both ICAO and CAR/SAM Region, the aircraft could have notified the ACC when entering the FIR. This will also help to eliminate the problems associated with the altering of courses by aircraft due to weather and turbulence that goes unreported in the southern area. Additionally, in a recent CAR/SAM meeting in Lima, Venezuela agreed to resolve the loss of communications problem between them and Brazil which affects the areas in question. We recommend the installation of at least 2 VHF ER platforms; one at Esmeralda and one at Canaima. These facilities should be able to cover approximately 175 NM at FL 270 and above. Due to the locations and the possibility of poor telephone lines, we recommend a VSAT at each platform to transmit the communications back to the ACC at Maiquetía.

Replace the VHF transmitters/receivers for the Maiquetía ATC facilities (12 units).

Some of these units are more than 30 years old and have a high failure rate. Some are not operable and have not been for some time. The major international civil airport needs to have operable communications equipment in accordance with Annex 10.

***Note**: We noticed that INAC has a plan to replace 18 transmitters/receivers in 2003 and 281 transmitter/receivers beginning in 2007. The two recommendations mentioned above should have priority, although it may behoove INAC to consider moving up that time schedule for the remainder of the VHF equipment or making a buy at the same time for all communications equipment.*

Implement the AMHS to replace the AFTN

The AMHS is a high capacity, high speed internet system that is fully complaint with ICAO ATN standards and recommended by CAR/SAM for 2005. It provides for the exchange of and distribution of message oriented traffic between ATC units. It replaces the non-ATN compliant AFTN. The AMHS is now operational and should be considered for implementation. In the initial implementation, the AMHS may require an AMHS/AFTN gateway to connect the ATS message server if the AFTN co-exists with AMHS, but only an ATS message server is required for the AMHS.

Continue with Phase II and III of the transition to the Digital Communications Network of CAR/SAM (REDDIG) in accordance with the schedule developed by CAR/SAM.

In 1994, the CAR/SAM Region began a CNS/ATM communication initiative, known as the CNS/ATM Digital Network (REDDIG), which is still under development. This initiative will provide efficient and cost-effective improvements to the Aeronautical Fixed Services (AFS) network and is ATN compliant. The REDDIG will serve both voice and data sub-networks, and is planned to greatly improve the ground-ground communications interfaces between CAR/SAM States.

Initiate the expansion of the Aeronautical Information Service (AIS)

The major objective of AIS is to ensure the flow of information necessary for the safety, regularity, and efficiency of international aviation. States are responsible for providing this information and the quality and accuracy of the information provided. With the advent of CNS/ATM, that information has become data dependent. The implementation of the Surface Management Advisor will aid this. Many of these new requirements still must be defined, but the general view is that AIS must provide information for guidance of an aircraft for a gate-to-gate (departure to destination) operation.

Implement PDC (pre-departure clearances) and D-ATIS (digital airport terminal information service) at the following four airports using VDL Mode 2: Barcelona, Barquisimento, Maiquetía, Maracaibo

VDL Mode 2 is an addressable, high speed, operational data link that features VHF data link using "Carrier Switching, Multiple Access (CSMA)" protocols, which operates at a faster baud rate of 31.5Kbps. This application of PDC and D-ATIS are in use at more than 56 airports worldwide. These benefits have been provided in the past using ACARS data link, but that link is not ATN compliant. VDL Mode 2 is now replacing the ACARS link. VDL Mode 2 is maturing rapidly and is the least expensive of the data links presently being considered for ATC purposes. However, with the advancement of AOA (ACARS over AVLC), Venezuela should be alert and if this link is approved with SARPS, AOA should be considered as the preferred link since almost all aircraft are equipped with ACARS.

Navigation

Immediately approve and implement GNSS using GPS as a primary means of navigation for en route and non-precision approach until 2006

This is the first event that must occur in the transition. Venezuela can move into the CNS/ATM realm and begin providing benefits with this approval. This approval will permit limited direct routing within the Caracas Flight Information Region (FIR) and limited non-precision approaches at Maiquetía. It will also relieve an aging ground-base navigation system while the system is still operational. More than 60 countries have approved GPS as a supplemental or primary means of navigation. No real benefits can be provided until this approval takes place. This option provides:

- Limited direct routes;
- Limited non-precision GNSS approaches including APV-1;

Participate in the development and approval of regional RNAV routes as determined by GREPECAS at FL 290 and above beginning with UT-410; designate RNP-10 for all RNAV routes developed through GREPECAS; develop and implement other RNAV routes within Venezuela in coordination with GREPECAS at or below FL 280.

With the approval of GNSS as a supplemental or primary means and with the development and use of RNAV routes, RNPs can now be assigned to all RNAV routes. GREPECAS has decided to begin their proposed RNAV routes within the CAR/SAM Region at FL 290 and above with RNP-10. This is a GREPECAS demonstration, but states are still free to develop other RNAV routes between States. INAC needs to develop other RNAV routes below FL 290 that will benefit Venezuela's users. Additionally, en route RNP values should be reduced to RNP-5 when the SBAS or GRAS becomes operational. Remember that when you designate RNP-5 for routes, you have required the aircraft to be certified for RNP-5 to use that route. Therefore the designation of RNP-5 for routes must be coordinated with the users and if you want them to apply on routes to and from Venezuela airspace, coordination with GREPECAS and the adjacent FIRs is required. Controller training would be required, as would the development of both air traffic control (ATC) and administrative procedures.

Even though the approval of RNP values is a state's responsibility, the approval process must be coordinated with the regional planning group, which in this case is GREPECAS. ICAO's Manual on Required Navigation Performance, second edition, 1999, (DOC 9163-AN/37) supports RNP-5 for routes that have widths of 20 KM. Therefore the designation of RNP-5 would be appropriate to permit some benefits and offer experience with RNP.

Develop GNSS non-precision approaches using RNP-0.3 for the following airports: Barcelona, Barquisimento, Maiquetía, Margarita, Puerto Cabello, Paraguana, maturing, Caracas, Santo Domingo, Coro, and Maracaibo; and 2 military airports of Venezuela's choice.

Procedures for Air Navigation Services-Operations (PANS-OPS) SARPS have been approved so that GNSS approaches can now be developed for candidate airports. Therefore, the next level is developing GNSS NPAs at the airports mentioned above, and the assignment of RNP-0.3 as the RNP value. These approaches will provide a benefit for the user and relieve an aging navigational aid (NAVAID) system. ICAO has approved RNP-0.3 as the accepted RNP value for GNSS non-precision approaches.

Develop limited GNSS departure and arrival procedures (Standard Instrument Departures-SID and Standard Terminal Arrival Routes-STAR).

INAC needs to develop a GNSS SID and STAR for Maiquetía to gain experience with these procedures. These procedures can be used on VMC days for demonstration purposes to acquaint both INAC personnel and users on how these procedures are flown using satellite navigation. These procedures should not be used anywhere other than Maiquetía and then only as a demonstration procedure until an SBAS/GRAS is operational.

Develop and implement APV-1 and APV-2 approaches at Maiquetía, Barcelona, Barquisimento, Maracaibo, Margarita, Puerto Cabello, Paraguana and Maturin

APV approaches are non-precision approaches with vertical guidance that have the potential to produce lower minimums than conventional non-precision approaches. APV-1 utilizes the GNSS system and the avionics in the aircraft to construct an electronic glide slope. In recent demonstrations, APV-1 approaches produced approach minimums well below conventional ground-based NPAs. The use of APV approaches could provide a NPA at every qualified airport in Venezuela. APV approaches are new approaches and have not yet receive approval from ICAO, which is expected soon. The demonstrational use now will provide the experience with them before they go into full production. Additional approaches should be developed during Phase II.

Participate with GREPECAS as a member of the CAR/SAM Satellite Test Bed to develop an SBAS option for South America that will provide sole means navigation within Venezuela; install test bed equipment including ground reference monitor and antenna in accordance with GREPECAS

The CAR/SAM Region has developed a CAR/SAM Satellite Test Bed (CSTB) with several South American countries participating. At present, Venezuela is not one of them. If Venezuela decides on using the SBAS, INAC needs to be involved in these trials and validations since they will eventually be part of the CAR/SAM SBAS. This initiative is already on going and will be used as a demonstration project until the South American SBAS becomes operational which is planned for the 2005/2006 timeframe. INAC should make every effort to become part of this demonstration. However, if they are unable to fund a portion of the cost, INAC personnel should be attending the CSTB meetings so as to have the expertise and experience when it is time for Venezuela to join the SBAS ranks with their own reference monitor.

Develop GNSS (SBAS) precision approaches beginning in 2005 to the following airports: Barcelona, Barquisimento, Maiquetía, and Maracaibo; and 2 military airports of Venezuela's choice.

Precision (CAT I) approaches are one of the benefits of augmented GNSS (SBAS/GRAS). Once augmented GNSS has been approved, installed, and certified, precision approaches using the augmentation can be developed. Augmented GNSS provides differential corrections of the GPS constellation including ionosphere corrections that will meet the accuracy requirements for RNP and for all phases of flight down to and including CAT I precision approaches. The SBAS/GRAS has the navigational accuracy to provide a potential precision approach to all airports. Approach development needs to start a year prior to approval of any augmented system (SBAS/GRAS).

During 2006, augment GNSS with an SBAS or GRAS as determined by GREPECAS or INAC, and in conjunction with the CAR/SAM Region, and approve GNSS as a sole means of navigation.

The decision to install either a SBAS or GRAS is a INAC decision. Both provide similar benefits and both have certain advantages. SBAS provides signals over a wider area, but the provider does not always have final say over what information in broadcasted where as the GRAS provides signals within a 225 NM radius of the transmitter, but the provider has complete control over the information provided. GRAS would require more ground stations than an SBAS. This option provides:

- Point-to-point navigation anywhere in the FIR;
- Non-precision approaches with lower minimums to all airports;
- Precision approach capability at most airports;
- APV-2 approaches at all airports;
- SIDs and STARs with lower departure minimums at all airports;
- Reduced separation minima;
- Lower RNP values for all phases of flight;
- Reduction of cockpit avionics; and
- Decommissioning of ground-based navigational aids.

Decommission all NDBs at end of operational life

NDBs are obsolete in several parts of the world now and will not be cost productive to maintain.

Develop APV approaches at the following major airports: Barcelona, Barquisimento, Maiquetía, and Maracaibo.

Non-precision approach with vertical guidance is at present a new concept in non-precision approaches. Using the accuracy of GPS satellites for azimuth and the capability of onboard avionics to provide an accurate electronic glide path, lower approach minimums can be obtained. These approaches are very similar to APV-1 approaches mentioned in Phase I, but will require the use of SBAS in order to gain the lower approach minimums. APV-2 approaches are still in the development stages, but it is expected that they should yield minimums near that of a CAT I precision approach. INAC must stay abreast of these developments now ongoing in ICAO. At present, the proposed RNP value for an APV-2 approach is expected to be near RNP-0.125.

Surveillance

Replace four radar systems presently in the INAC inventory.

Our on-site assessment revealed that four of Venezuela's radars are more than 20 years old, some between 23-28 years old, and all lack the advance automation that is common to advanced radar. Separation standards used with the present radar systems are excessive due to unreliability. Three other approach controls that have radar, Barquisimento, Maracaibo and Margarita provide only radar information within their jurisdiction, but not radar control (separation). It appears that radar is not being used to its fullest potential, which may be caused when radar is not certified due to age and/or lack of spare parts. The ASR-11 is on the cutting edge of solid-state technology. It is modular, fully solid-state, primary radar systems that incorporate the latest technology in airport surveillance radar systems with secondary coverage out to 250 NM. This will be an expensive initiative for INAC. INAC may want to extend the purchasing of these systems rather than pay all at once. However, it is important that INAC fund at least one radar system a year so that one system can be operation by the 2006 time frame and all of the systems operational by 2009.

Air Traffic Management

Procedure Development/Letters of Agreement

Even though INAC may be short of controllers, a number of controllers determined by INAC should be assigned to ensure the development of procedures to be use in a primary environment for GNSS. Operational procedures must be in place so controllers will know how to provide the benefits associated with a CNS/ATM environment. Letters of Agreement need revisions and new aviation circulars need to be developed. Even though the benefits may be limited, procedures need to be in place. As benefits are expanded procedures will need to be revised or re-written. Several countries are already providing user benefits and many already have procedures developed. INAC should not re-invent the wheel, but contact these countries and have them send copies of these procedures. INAC can then tailor them to Venezuela's need. Refresher and currency training needs to begin immediately for both controllers and technicians.

Procure and implement a Flight Data Processing System (FDPS) or an Air Traffic Management system (ATM).

Venezuela can not continue processing flight plans and flight data manually. In the on-site assessment, the flight data position was the busiest position in the ACC and has the largest area. Strips get lost, flight data is not always passed in an appropriate or timely manner, and aircraft movements are not always counted correctly. The recovery of funds that result from a lost of over-flight count in a manual system may almost pay for a flight data processor. Both systems, FDPS or ATM System, will process flight plan information

from the AFTN or AMHS, provide strips for each control position, perform coordination functions, reduce the excessive coordination requirements at the busier facilities, eliminate transposing errors, and will eliminate the errors and workload associated with manual processing and counting of strips and aircraft movements. However, only the ATM system, based on its radar data acquisition capability, has the ability to record aircraft entry and exit times of Venezuelan airspace automatically. The ATM system has considerably more storage capacity and has radar data processing capability. Therefore we are recommending an ATM system for INAC. We have also recommended the installation of IP/OP (input/output) devices to be installed in the 10 busiest civil facilities including Barcelona, Barquisimento, Maiquetía, Maracaibo, Margarita, Puerto Cabello, Paraguaya, Maturin, Caracas, and Santo Domingo. An additional 4 military units would be installed at locations by INAC's discretion.

Develop SIDs (Standard Instrument Departures) and STARs (Standard Terminal Arrival Routes) at following major airports; Barcelona, Barquisimento, Maiquietía, Maracaibo, Margarita, Puerto Cabello, and Paraguaya; more airports as experience is gained

With the addition of SBAS/GRAS and the approval of sole means, SIDS and STARS can be developed using RNP-2 or even lower. The accuracy and availability of SBAS/GRAS (augmented GNSS) will provide narrow departure routes thereby reducing the obstruction clearance area. Utilization of the SBAS/GRAS could provide lower RNPs for arrival procedures as well. Departure routes and arrival routes can be based on the shortest and most direct routes since navigation will not depend on ground-based aids.

Develop a "Center Stored Flight Plan" program.

A "center stored flight plan" program will enhance and reduce time consuming functions at the flight data position. This program would be maintained by INAC, but initiated by the users. The users who had scheduled flights on a daily basis or at least a frequent basis going to the same destination via the same routing and requesting the same altitude can participate. They simply provide this flight plan to INAC who will store them and print this flight plan out each day two hours before flight time. If a user wants to change the flight plan, he notifies the office in charge of this program a few hours prior to the time the flight plan is printed. A change is then made. Aircraft can always requests altitude changes on frequency. This would ease the workload at the flight data position. An ATM system has the storage capability to provide this concept.

Phase II (2007-2010)

Communications

Replace all remaining VHF platforms that are 20 years old or older.

These radios are not upgradeable for future use of data link. We noticed there is a plan for replacing 281 transmitters and receivers in 2007. We believe this should start sooner.

Implement the use of HF voice/data link for non-routine and emergency ATS communications

While preparations are underway to expand VHF coverage within Venezuela, there are times when emergency communications are needed. HF is available and can be used for these instances. HF communications should be available at various sites for emergency situations and as a backup for VHF communications. The expansion to HF data link will provide the oceanic sector with an additional means of long-range communications. A requirement should be determined prior to investing any funds in procuring an AMSS, although we have recommended it in Phase III for oceanic improvements.

Implement two VDL Mode 2 facilities at Esmeralda and Canaima to support the ADS-A recommend in Phase II under surveillance.

Two ADS units have been recommended for Phase II to provide surveillance in the southeastern portion of Venezuela. We recommend they be placed at Esmeralda and at Canaima along with the VHF ER platforms. There is sufficient traffic in this area to warrant surveillance and radar is not available or possible due to the terrain

Implement AIDC in accordance with CAR/SAM Plan

Another sub-network of the ATN is AIDC (ATS Interfaculty Data link Communications). ADIC is a digital application that supports the exchange of ATC related information between ATS units in support of critical ATC functions. This exchange includes the notification of flights approaching a Flight Information Region (FIR) boundary, coordination of boundary crossings, and the transfer of control. Other AIDC messages support ancillary ATC data exchanges between ATS units such as ATC restrictions, change in trajectories, etc. Although AIDC is considered a subnetwork of the ATN, almost all AIDC initiations will be initiated by an ATM system or an automated Flight Data Processor (FDP), but will pass through the ATN.

Implement a full Aeronautical Telecommunications Network (ATN).

Phase I calls for the limited implementation of the ATN with the AMHS. Phase II provides for AIDC. Now it is time to add the sub-networks to implement the full ATN implementation. All modifications to both the hardware and software should be completed by 2006. The ATN sub-networks, which will include VHF, HF, etc., will be interfaced (software installations) into the full ATN beginning in 2007 or 2008. ATN workstations should be installed in the approach control and at the outlying facilities. When Venezuela has the capability, the Aeronautical Information Service should be added as a sub-network.

Implement CPDLC with VDL Mode 2 in those areas where a distinct benefit can be achieved.

At present we believe benefits can be achieved in the central and southern area of Venezuela's domestic airspace. We recommend VDL Mode 2 as the data link and we believe 6 stations would provide the coverage needed. Our recommended stations include Esmeralda, Canaima, Maracaibo, Valencia, Puerto La Cruz, and Cuidad. However, we recommend that an additional cost study be performed to ensure that the addition of CPDLC will provide a benefit and at a reasonable cost.

Navigation

Continue developing APV 1 and 2 approaches at Margarita, Puerto Cabello, Paraguaya, Maturin, Caracas, and Santo Domingo; develop then at other airports where a lower minimum may provide an advantage to the user:

This is a continuation of the APV approaches development effort in Phase I

Develop GNSS NPAs at Margarita, Puerto Cabello, Paraguaya, Maturin, Caracas, and Santo Domingo; develop then at other airports where a lower minimum may provide an advantage to the user:

This is continuation of NPAs to the remainder of the eligible airports in Venezuela

Surveillance

Install and implement ADS-A in Central and Southern Venezuela

We estimate that this recommendation would need 2 VHF platforms using VSAT technology to transmit information to MQI. We suggest the same platform for ADS-A be used as for the VHF ER (extended range) units recommended in Phase I which are at Esmeralda and Canaima. It would require a VHF transmitter/receiver, modem, transponder time, a multiplexer, and ADS work stations. There is sufficient en route traffic between Brazil and Venezuela that warrants a surveillance capability.

Implement ADS-B at Maiquietía, Barcelona and Maracaibo.

ADS-B can be used to provide surface surveillance around the airport providing separation between aircraft, vehicles, and buildings. Aircraft can be issued taxi instructions and provide their own separation between other aircraft, vehicles and buildings. It can also be used to provide separation on SIDS and to permit departures in zero visibility. Mode-S may be the most definitive link for ADS-B, but is still a few years away from maturity. As a transitional link we recommend Universal Access Transceiver (UAT) or ACARS over AVLC (AOA).

Air Traffic Management

Implement other RNAV routes within Venezuela in coordination with GREPECAS at or below FL 230

Venezuela is large enough so that RNAV routes can be developed for internal use. These routes would be developed for the lower altitudes at and under FL 230 to provide benefits for local Venezuelan aircraft.

Reduce all RNAV routes from RNP-10 to RNP-5 when SBAS/GRAS is operational.

With the implementation of SBAS and the designation of sole means navigation, RNPs can be reduced. With SBAS, the accuracy, integrity, and available of satellite signals are greatly improve thereby permitting the reduction of RNP values. SBAS/GRAS supports RNP-5 without any further testing or demonstrations. The designation of RNP-5 for routes must be coordinated with the users and GREPECAS. Controller training would be required, as would the development of both air traffic control (ATC) and administrative procedures.

Develop and implement additional or revised Letters of Agreement between Maiquetía ACC and adjoining ACCs and with all approach controls within their jurisdictions that reflect the benefits and new procedures associated with augmented GNSS and ADS.

Although this was an initiative in Phase I, it needs to be repeated due to the new initiatives that have been offered through augmented GNSS, ADS-A, and ADS-B. .

These LOAs must include the procedures that will provide a seamless airspace such as extended RNAV routes, similar RNP values, airspace boundaries that promote rather than hinder direct navigation, and coordination procedures that reduce frequency changes, altitude changes, and controller workload.

Reduction in MEA/MRA/MOCA

MEA (minimum en route altitude) MRA (minimum reception altitude) and MOCA (minimum obstruction crossing altitude) are based on the reception range of ground-based navigational aids. MRA determines the MEA since the MEA can not be lower than the reception altitude of the ground-based aid. MRAs are based on the reception range of the navigational aid, therefore they are higher in the mountainous and remote areas due to the height of mountains and the distance between aids. The MOCA is based on the MRA and MEA. With GNSS and reception of signals, these limitation or restrictions to flight can be reduced.

Implement RVSM (Reduced Vertical Separation Minima) in domestic airspace

The amount of overflights and the time window that they operate through Venezuela would demand RVSM procedures. Most of the Northbound and Southbound overflights through Venezuela operate during the evening hours. This provides an excellent opportunity to utilize RVSM procedures. Due to the cost involved we recommend that GPS monitoring be used to eliminate the need for expensive ground-based monitoring units. Additionally, GPS monitoring would be a user expense and provider's expenses would be minimum. Since this would have regional effect, this initiative should be developed and approved through GREPECAS. This will increase capacity and is no cost, non-laborious initiative.

Implement Surface Manager Advisor (SMA) at MQI to enhance the Aeronautical Communications Service (AIS).

This tool will provide a network among airport operators to disseminate meteorology products, flow control issues, airport delays, and many other issues that effect airport and surface management.

Implement A-SMGCS at MQI.

A-SMGCS is an advanced lighting system that eliminates runway incursions. It identifies each aircraft and monitors their progress around the airport continuously; it automatically determines conflict-free taxiway routes and guides aircraft and vehicles reliably through the use of optical signals, and in case of deviations, automatically warns aircraft and vehicles. It enhances safety and productivity at airports. A-SMGCS includes software and lighting fixtures.

Implement metering and spacing tools (CTAS-URET P-fast).

The use of metering and spacing tools is supported by ICAO in the ICAO Global CNS/ATM Plan. Center/Terminal Automated Sequencing (CTAS) and Passive-Final Approach Sequencing Tool (P-fast) are metering and aircraft spacing tools. User Request Evaluation Tool (URET) automatically predicts and notifies controllers of conflicts between aircraft or special activity airspace. The system also allows controllers to quickly determine whether proposed flight path changes will conflict with en route traffic or airspace. Radar is required for these tools. These tools will provide both visual and graphical editions to sequencing at busy airports. These radar tools are used by controllers to set up an orderly sequence to the runway and eliminated delay and confusion.

Implement Traffic Flow Management Program

No longer are arriving aircraft held at approach fixes or in delay absorption patterns. Nor are en route or terminal sectors inundated at various periods of time with unmanageable air traffic flows. Aircraft are now held on the ground and given expected departure times, which reduces the overall delay, saves time and fuel, and eases the controller workload. Brazil is developing a flow control program on behalf of CAR/SAM and Venezuela should be a party to the implementation of this program.

Phase III (2011-2014)

Communications

Implement Mode S ,UAT, or AOA as a gap filler for ADS-B at Maiquetía

Although Mode S may be the data link of choice for ADS-B in Venezuela, many aircraft will not be outfitted with this link until later in the transition. UAT and AOA are potential gap fillers for ADS-B. Venezuela needs to keep up with this technology to determine which link may be the best for them. Both are still under development and are being demonstrated in various trials around the world. SARPS for both links are expected in 2004.

As previously stated AOA is a method where by ACARS uses the VDL Mode 2 protocol to become ATN compliant. UAT is a wide band, broadcast concept that is presently undergoing trials in the continental United States and in Alaska with the Capstone project. Both are presently being used for ADS-B applications. Thus far, both have been used as a demonstration system. They have not been developed to an adequate level for commercial availability but are considered to be promising links when mature.

Navigation

Decommission ground-based VOR/DME system while maintaining a skeleton ground-based VOR/DME navigational system.

This will permit a backup system to GNSS if Venezuela desires. Venezuela needs to identify the facilities they want to maintain, but a cost reduction is obtained when these facilities are decommissioned. This is not a requirement, but many countries are planning on maintaining a limited VOR/DME system with GNSS.

Surveillance

No new surveillance activities are planned for Phase III

Air Traffic Management

Develop and implement, on a progressive basis, reduced separation minima in domestic airspace for aircraft that are properly equipped using RNP.

Currently, the United States, Australia, New Zealand, and Fiji have reduced the en route longitudinal and lateral oceanic separation in the Pacific Ocean from 10 minutes longitudinally to 50 NM and from 100 NM laterally to 50 NM, and are in the process of reducing that further to 30 NM. This has been made possible by ADS with 15 minutes updates and aircraft certified to RNP-4. While this is over oceans, it demonstrates how a combination of RNP and ADS are being used to reduce separation standards. The United States and Canada are using 20 NM longitudinal separations based on GNSS reports in the Northern tier of North America. This standard could easily be implemented in the Venezuela when ADS is operational.

Additional reductions in both lateral and longitudinal separation standards are possible using RNP and ADS or a combination of both. RNP-2 is presently being demonstrated in Alaska with excellent results. Longitudinal separation of 10 NM using GNSS and RNP is also presently being demonstrated in Fiji. Venezuela needs to utilize the results of these other trials and demonstrations, and approve reduced minima on a selective basis.

Strengths and Weaknesses of CNS/ATM Plan

Strengths of CNS/ATM Plan

- Establishes sole mean capability with SBAS or GRAS which provides the following:
    - Point-to-point navigation anywhere in the FIR;
    - Non-precision approaches with lower minimums to all airports;
    - CAT I precision approach capability at most airports (SBAS); Cat II or CAT III with GRAS
    - SIDs and STARs with lower departure minimums at all airports;
    - Reduced procedural separation minima;
    - Lower RNP values for all phases of flight;

  - Reduces cockpit avionics;
  - Provides for APV-1/2 approaches with lower minimums;
  - Decommissioning of ground-based aids
  - Improves system wide communications infrastructure;
- Provides for SIDs and STARs; developmental through 2005;
- Initiates data link technology with ADS-A and ADS-B;
- Eliminates strip preparation and manual processing of flight plans;
- Reduces excessive coordination;
- Provides accurate counting of overflights;
- Meets the needs of the current and future system capacity;
- Provides for a GNSS NPA capability to all airports;
- Provides GNSS precision and APV-1/2 approaches beginning in 2006;
- Permits early benefits for equipped aircraft;
- Early use of ATN (AMHS) for processing flight plans and passing flight data;
- Provides improved ATC communications for ATC facilities;
- Provides RNP capability for all phases of flight and airspace:
- Relieves an aging ground-based navigational system while it still operates;
- Maiquetía ATC radar and communication infrastructures are improved;
- Provides an RVSM capability;
- Savings through discontinuance of ground-based systems;
- Provides precision approach capability with SBAS or GRAS;
- Meets the current and future ATC growth requirements of Venezuela
- Improves pilot and controller awareness;
- Provides an RNAV capability;
- Relieves a majority of controller coordination activities;
- Provides an automated method of clearance delivery and ATIS;
- Provides improved surveillance over some of Venezuela through new radar;
- Provides automatic sequencing to the airport at MQI;
- Provides a platform for close collaboration between user and provider with SMA;
- Adds additional data link capability;

- Complies with several ICAO/CAR/SAM Regional recommendations;
- Provides a center stored flight plan program; and
- Provides an improved airport management program with A-SMGCS
- With GRAS, a CAT II or CAT III precision approach can be provided.

Weaknesses of CNS/ATM Plan

- More controllers and technicians needed to operate and maintain the new radars;
- Controller and technician training required;
- No GNSS CAT II or CAT III capability with out GRAS.

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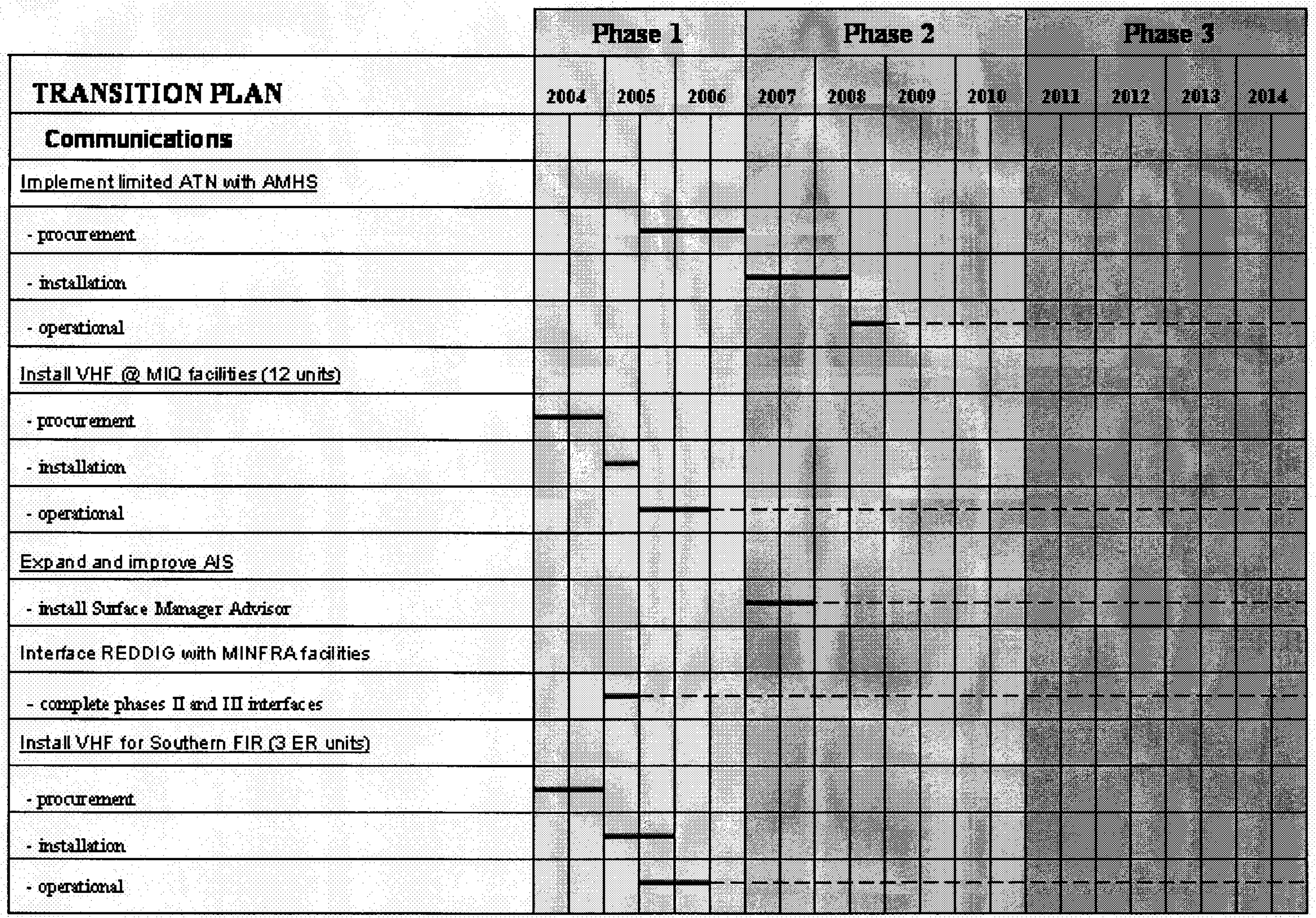
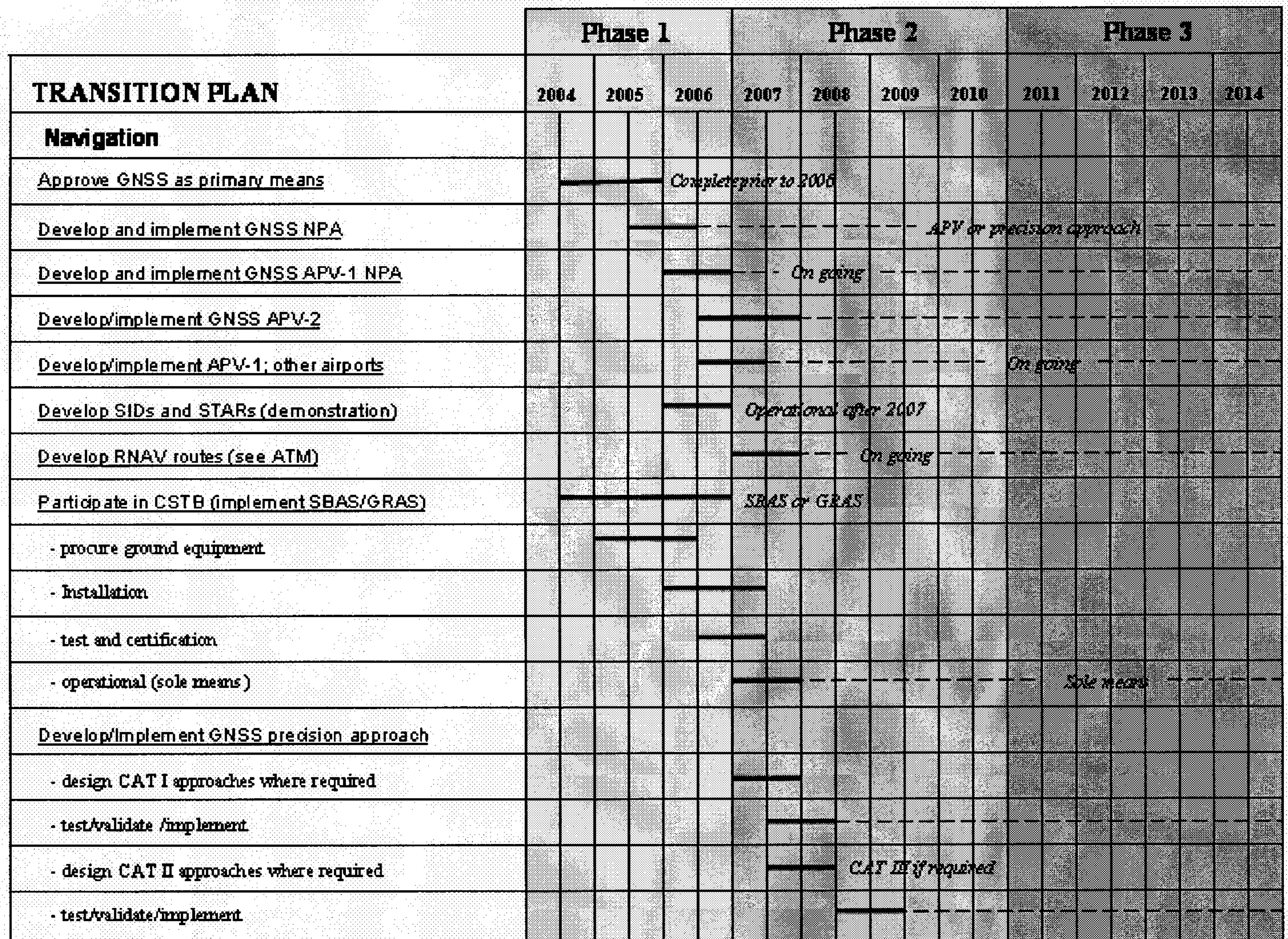
Appendix A: Schedule


Phase 1
Phase 2
Phase 3
TRANSITION PLAN
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Communications
Implement limited ATN with AMHS
- procurement
- installation
- operational
Install VHF @ MIQ facilities (12 units)
- procurement
- installation
- operational
Expand and improve AIS
- install Surface Manager Advisor
Interface REDDIG with MINFRA facilities
- complete phases II and III interfaces
Install VHF for Southern FIR (3 ER units)
- procurement
- installation
- operational

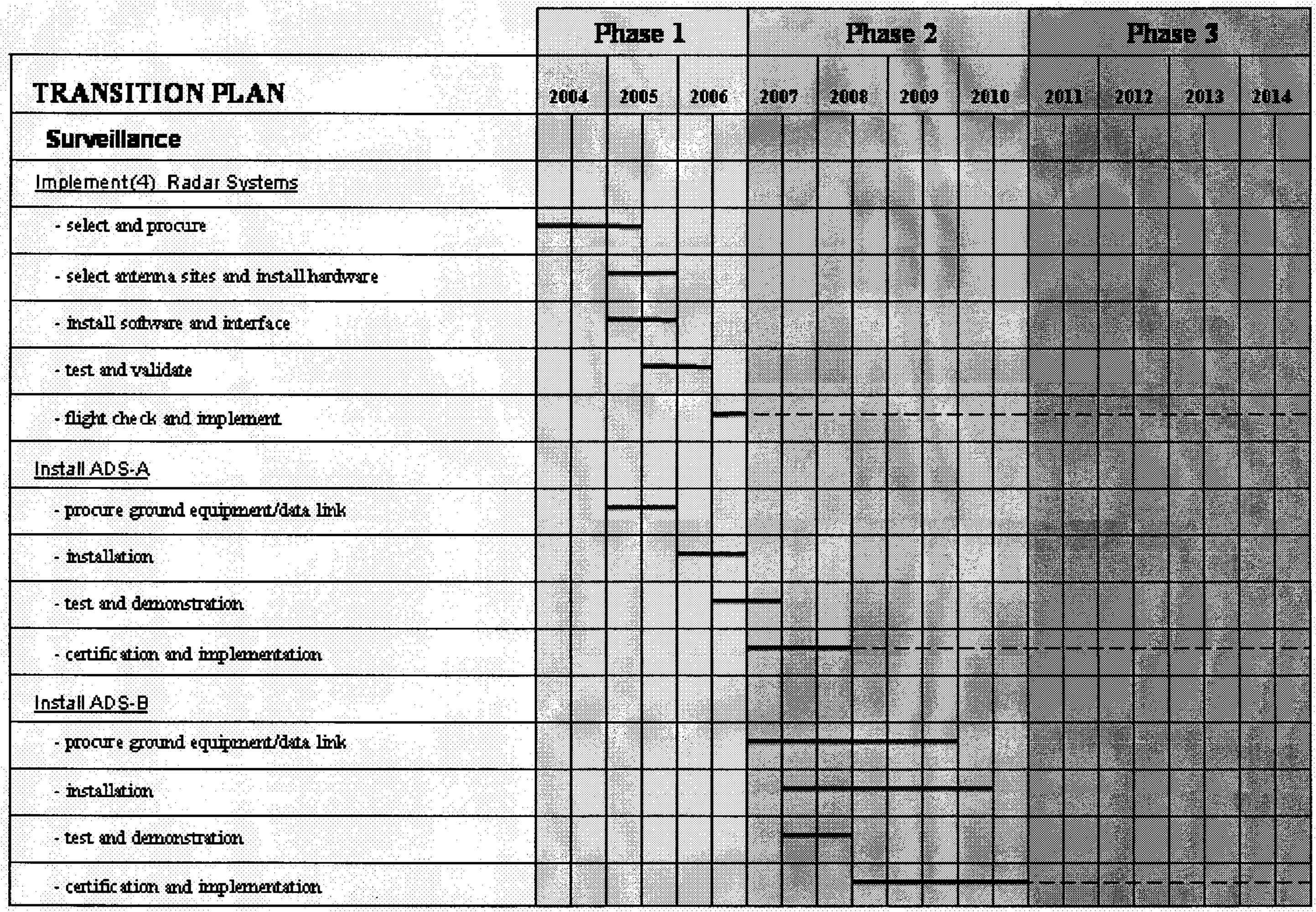
TRANSITION PLAN	Phase 1			Phase 2				Phase 3			
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Communications (continued)											
Install AIDC for ATN											
- procurement											
- installation											
- operational											
Implement PDC and D-ATIS using VD M2											
- procure hardware and software											
- installation											
- test/certification/operational											
Implement HFDL for non-routine use											
Implement VDL Mode 2 for ADS-A											
Implement full ATN with sub networks											
- procurement software											
- installation											
- operational											
Implement CPDLC											
- procure hardware and software											
- install and validate											
- test/certify/operational											

TRANSITION PLAN	Phase 1			Phase 2				Phase 3			
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Communications (continued)											
Implement UAT/AOA data link											
- procure and install ground equipment											
- test and validate											
Install/certify AMSS for oceanic control											


Phase 1
Phase 2
Phase 3
TRANSITION PLAN
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Navigation
Approve GNSS as primary means
Complete prior to 2006
Develop and implement GNSS NPA
APV or precision approach
Develop and implement GNSS APV-1 NPA
On going
Develop/implement GNSS APV-2
Develop/implement APV-1; other airports
On going
Develop SIDs and STARs (demonstration)
Operational after 2007
Develop RNAV routes (see ATM)
On going
Participate in CSTB (implement SBAS/GRAS)
SBAS or GRAS
- procure ground equipment
- Installation
- test and certification
- operational (sole means)
Sole means
Develop/Implement GNSS precision approach
- design CAT I approaches where required
- test/validate /implement
- design CAT II approaches where required
CAT III if required
- test/validate/implement

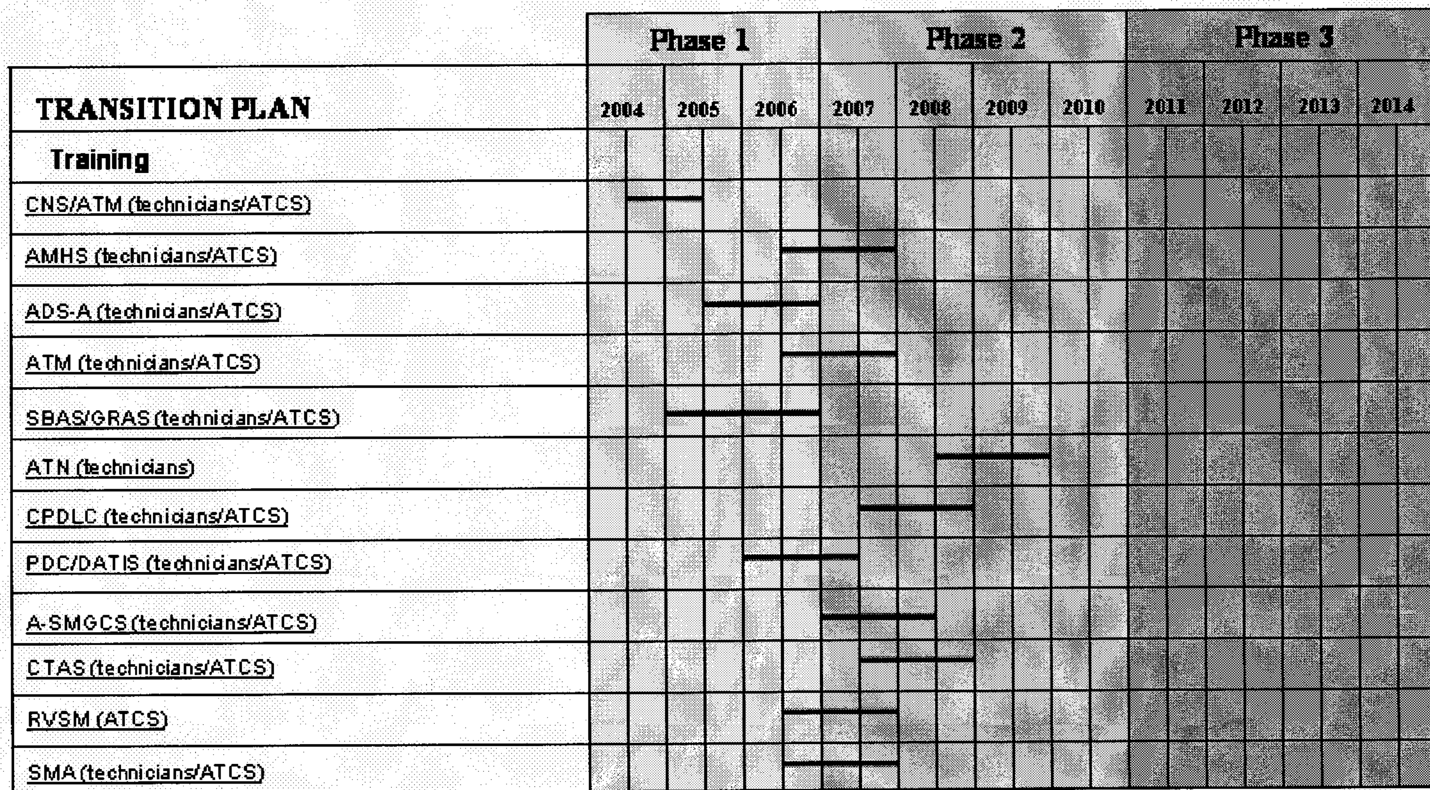
TRANSITION PLAN	Phase 1			Phase 2				Phase 3			
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Navigation (continued)											
- design SIDs and STARs where required											
- test/validate/implement											
Decommission NDB facilities						*Complete by 2009*					
Reduce RNAV routes to RNP-5											
Decommission ground-base system											

TRANSITION PLAN	Phase 1			Phase 2				Phase 3			
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Surveillance											
Implement (4) Radar Systems											
- select and procure											
- select antenna sites and install hardware											
- install software and interface											
- test and validate											
- flight check and implement											
Install ADS-A											
- procure ground equipment/data link											
- installation											
- test and demonstration											
- certification and implementation											
Install ADS-B											
- procure ground equipment/data link											
- installation											
- test and demonstration											
- certification and implementation											


Phase 1
Phase 2
Phase 3
TRANSITION PLAN
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Surveillance
Implement(4) Radar Systems
- select and procure
- select antenna sites and install hardware
- install software and interface
- test and validate
- flight check and implement
Install ADS-A
- procure ground equipment/data link
- installation
- test and demonstration
- certification and implementation
Install ADS-B
- procure ground equipment/data link
- installation
- test and demonstration
- certification and implementation

TRANSITION PLAN	Phase 1			Phase 2				Phase 3			
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Surveillance (continued)											
Develop/install controller tools											
- CTAS											
- URET											
- pFast											
Institute Flow Management Procedures											
Reduce Separation criteria											

TRANSITION PLAN	Phase 1			Phase 2				Phase 3			
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Air Traffic Management											
Procure ATM system											
- procurement ATM system (14 stations)											
- install workstations/IP/OP units											
- interface with radar											
- test/validate/implement ATM											
Develop Letters of Agreement for GNSS						*On going*					
Develop internal RNAV routes with RNP											
- determine routes											
- develop and demonstrate											
- approval and publication							*On going*				
Implement center stored flight plans											
Implement RVSM											
Implement Surface Manager Advisor											
Implement A-SMGCS @ MQI											
Reduce MEA/MOCA/MRA								*On going*			
Review LOAs for SBAS/GRAS/ADS-A/B								*On going*			


Phase 1
Phase 2
Phase 3
TRANSITION PLAN
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
Training
CNS/ATM (technicians/ATCS)
AMHS (technicians/ATCS)
ADS-A (technicians/ATCS)
ATM (technicians/ATCS)
SBAS/GRAS (technicians/ATCS)
ATN (technicians)
CPDLC (technicians/ATCS)
PDC/DATIS (technicians/ATCS)
A-SMGCS (technicians/ATCS)
CTAS (technicians/ATCS)
RVSM (ATCS)
SMA (technicians/ATCS)