Preparedness of Philippine Aviation in Implementing Automatic Dependent Surveillance – Broadcast (ADS-B) System

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Abstract

Air transportation is challenged by the increasingly high-density airspace traffic, thus aviation being a very complex system is highly reliant on technology advancements to ensure the highest levels of safety. As aviation transitions from a ground-based system to a satellite-based system, a wide scale of system re-designing presents one of the biggest system engineering challenges to aviation organizations globally. Countries in America and Europe, faced with very high traffic density, have since been working on the preparation for this transition. The Asia Pacific region is in the same predicament, driven by a surging demand that will account for more than half of the new air passenger traffic forecast in the region, according to the latest edition of IATA's 20-year forecast from 2015 to 2035. This research aims to assess the preparedness of Philippine Aviation in Automatic Dependent Surveillance – Broadcast (ADS-B) transition and to determine the key success factors to an eventual ADS-B implementation, by way of benchmarking with the latest and more advanced US Federal Aviation Authority (FAA) and European Union (EU) Eurocontrol surveillance systems.

Keywords:
Automatic Dependent Surveillance – Broadcast (ADS-B), surveillance technology, airspace capacity, aviation system,

1. Introduction

Satellite-based surveillance such as the ADS is a promising technology that is seen in the aviation community to be at least a substitute to if not at all to replace or supplant radars – the most widely used and time-proven reliable surveillance technology for over half a century. The first that became popular – the ADS-C technology was first explored in the 1990s. As intended, as the primary means of surveillance in the oceanic airspace were radar could not simply cover. There has been a lot of work done and money spent to push this to the aviation industry but suddenly it is hardly been heard of nowadays, since the introduction of ADS-B at the turn of the century. ADS-C has a corresponding communications technology that comes together with its implementation called the Controller-Pilot Data Link Communications (CPDLC). However, the CPDLC program spearheaded by the United States Federal Aviation Administration (FAA) had been cancelled.

The Philippines has its trial of the ADS-C/CPDLC in the late 1990s through the Japan International Cooperation Agency (JICA) grant of ATC equipment and a free trial for interested airlines whose aircraft fleet is equipped with the corresponding avionics for this satellite-based surveillance technology. Civil Aviation Authority of the Philippines (CAAP) – the Air Transportation Office (ATO) then, conducted the trial for oceanic airspace with the adjacent Flight Information Region of Japan. The use of the ADS-C/CPDLC, which is normally a pay-per-message service because of the use of satellite for the communication part of the data and controller-pilot dialogue, was given free during the trial to participating aircraft. However, right after this free trial, no airline is willing to pay for the succeeding service. The ADS-C/CPDLC equipment granted by JICA has been decommissioned in 2003 (Japan, 2003).

Since 2001, the Philippines, through CAAP, participated in the International Civil Aviation Organization (ICAO)-created ADS-B Task Force, would like to embark on the ADS-B technology and has allotted budget in the last three

(3) years for the installation of ground stations. However, in July 2016 at the Ninoy Aquino International Airport, reports on different flights from four airlines stated that they experienced Global Positioning Satellite (GPS) interference, signal loss, or navigation problem during the flight's area navigation approach.

With the recent and sudden decision, as proposed by the Air Navigation Service and the Air Traffic Service of the CAAP, in compliance with the commitment made in the international community. This, together with the knowledge of the irregularities observed using the Tagaytay Mode S Radar with Enhanced Surveillance and ADS-B reception capability, made the author seek to find out whether the Philippine Aviation is prepared to implement the ADS-B technology. While most of the first-world countries that undoubtedly handle very high traffic density have advanced their preparation of ADS-B implementation for more than a decade and a half. The preparation done would only introduce half of the promised benefits of the ADS-B. More so, there are still uncertainties on their works to meet even the first half of their baseline objective.

This research would evaluate the activities done by the Philippine Civil Aviation Authority, to find out where it is at present compared to other countries and give guidance on how preparation in using ADS-B in the condition of the Manila Flight Information Region be localized and make its promise benefit tangible to Philippine airspace users. The study would find out the constituents needed and necessary steps to take for a successful implementation of ADS-B for use in Philippine aviation as a surveillance technology. The objectives are (1) to determine and assess the local conditions of the Philippine Aviation relative to the implementation of the ADS-B and possible capacity enhancement through new overflight routes based on ADS-B control; (2) to identify the different capabilities, configurations, behaviors, characteristics, constituents (systems and standards) for which ADS-B technology is dependent upon; dynamics, processes and/or procedures necessary to undertake it to operational implementation; different elements affecting the implementation of ADS-B using the FAA's and Eurocontrol's approach as a benchmark; and, (3) to formulate strategy and/or policy framework that addresses safety, capacity demand, efficiency and/or the seamless introduction of ADS-B technology in the context of Philippine airspace.

The scope of the research will mainly be on the technical factors/aspects/elements of the goals stated above. Should there be non-technical aspects (e.g., human factors, environmental, financial/cost) that are integral to the goals, they may be mentioned for description purposes but will not be part of the factors to be weighed-in on the measurement or comparison with another countries/region's implementation. Technical factors/aspects would be those relative to intended application/s, safety consideration/s, performance, and operational hard (equipment-based) and soft (e.g policy, rules, regulations, procedures) requirements. The scope includes ANS Provider, regulator, and aircraft operators' concerns; the need in the current traffic condition of the Philippine airspace wherein the use of ADS-B will be beneficial; documented programs that lay out the roadmap to take to achieve the same safety level provided by radar technology in the application of ADS-B; the risks and sufficient mitigation plans to counter the risks in the ADS-B implementation identified; preparation that the aviation authority needs to accomplish to implement the new technology safely; the preparation of the aviation authority to do at least a trial implementation; technical preparation (study, evaluation systems, and trial system); and, documented implementation plan in terms of infrastructure, regulation and procedure. Since the topic has broad coverage and is quite complex, the time available for this research would restrict the investigation of different aspects of preparations necessary to achieve trial implementation requirements. Benchmarking will be limited to the FAA and/or Eurocontrol study/implementation approach. Procurement and/or contracting structure and implementation issues are not included.

The study can provide a platform for crossroad decision situations faced in adopting new technology for civil aviation application. Proper planning will prevent unnecessary and undue capital expenditure for all stakeholders in civil aviation.

2. Methodology

Operational requirements based on traffic demand are the primary consideration for any major technological advancement. Hence, local airspace conditions considered start from air traffic data and/or statistics, which will be used for traffic data analysis and/or forecasting. The forecast that lines up with ICAO's Global Plan until 2030 will serve as the baseline traffic demand. Other baseline surveillance parameters of the Philippines juxtapose with the FAA and Eurocontrol before the ADS-B implementation planning. This includes aircraft registration Mode S address assignment, regulation, monitoring, and control; current radar-based surveillance infrastructure and model; existing safety model; and current separation standard/model at the very least. Processes gone through by FAA and Eurocontrol that is significant step in the planning and implementation and/or which has localized implications specific to Philippine condition will have to be adopted on relative local situation.

2.1 Design and Instrumentation of the Research

The fact that the implementation of ADS-B is a global aviation issue and interoperability is at least a continent-wide concern, the research locale is the aviation community. Data needed and only applicable for Asia-Pacific will be sourced from the aviation community in Asia-Pacific. ADS-B technology-related data will be sourced from countries with scientific research and manufacturing of ADS-B related equipment through the internet. In the Philippines, data sources include the Civil Aviation Authority of the Philippines' information sources (e.g. website, publicly available documents). The recordings from the Tagaytay Mode S radar is also to be used. Other materials/documents such as the following will be referenced such as ICAO and ADS-B Task Force documents; Eurocontrol and FAA documents; RTCA and Eurocae documents; other published and circulated materials; and, sample data from Tagaytay Mode S Radar recording.

2.2 Current Assessment of Philippines' Surveillance-Related Domain

The Manila Area Control Center (Manila ACC) automation system is the system where flight plans are encoded in the Flight Data Processing System (FDPS). The flight data in the FDPS are then fed to the Radar Data Processing System once the flight becomes active. All flight movements are recorded in the automation system. Data from this record can be extracted to MS Excel file and show the different information regarding the flight such as flight identification, aircraft type, estimated time of departure (ETD), estimated time of arrival (ETA), entry and exit point/time, flight type (e.g. Military, Schedule), flight category (e.g. arrival, departure, international, overfly), movement category (e.g. domestic or international) among others. Considering the total flights recorded in different categories, table 2.2.1 shows approximately 1260 average daily flight operations in 2016. There is something unclear in the data classification; nonetheless, it is worth noting that the automation system is connected to the existing three (3) en route radars in Laoag, Tagaytay, and Mt. Majic; and, the Manila ACC volume of airspace responsibility starts from flight level 13,000 feet and above. Tagaytay radar coverage can reach some airports (e.g. NAIA and Clark) up to the ground level; hence, aircraft signal is captured and processed by the radar and included in the transmission to the Manila ACC automation for processing. This may explain why there are few numbers in the arrival and departure count of domestic movement category while it is definite that the traffic movement (i.e. departure and arrival) data as recorded by individual airports for domestic flight is higher.

Table 2.2.1 Manila ACC System Record in 2016

Flight Category	Monthly Ave	Daily Ave
ARR		
DOMESTIC	3	1
INTERNATIONAL	6031	201
ARR Total	**6034**	**201**
DEP		
DOMESTIC	20	1
INTERNATIONAL	6093	203
DEP Total	**6113**	**204**
INT		
DOMESTIC	15288	510
INTERNATIONAL	86	3
INT Total	**15374**	**512**
OVF		
INTERNATIONAL	10207	340
OVF Total	**10207**	**340**
Grand Total	**37728**	**1258**

Based on the traffic movement record of different Philippine airports from 2001 to 2015 as shown in table 2.2.2, traffic forecast/trend in the throughout the Philippine aerodromes will reach 1.86 Million by 2030. To have a traffic movement data comparison with approximately the same airspace area, New York/New Jersey traffic movement was compared. The forecast/trend analysis showed that by 2030, Philippine will exceed the New York/New Jersey at 1.58 Million. The data are not accurate. It was verified that the data gathered from the Aerodrome Design and Management Service (ADMS) are doubled in figure compared to the actual records of individual airports. Hence, the figures were adjusted back to half. Table 2.2.2 also shows that by 2030, traffic movement in the Philippines will not even reach the figures of New York/New Jersey in 2001, short of about 300,000 movements.

Table 2.2.2 Philippines and New York/New Jersey Aircraft Movement Statistics

Year	ADMS Stat	CAAP Forecast	CAAP Trend	NY Stat	NY State Forecast	NY Trend
2001	343,039	343,039	237,154	1,284,811	1,284,811	1,332,062
2002	365,138	365,138	293,057	1,264,247	1,264,247	1,340,512
2003	374,449	374,449	348,960	1,265,905	1,265,905	1,348,963
2004	372,491	372,491	404,863	1,371,685	1,371,685	1,357,414
2005	328,969	328,969	460,766	1,394,930	1,394,930	1,365,864
2006	326,510	326,510	516,669	1,494,693	1,494,693	1,374,315
2007	609,609	609,609	572,572	1,540,511	1,540,511	1,382,765
2008	565,894	565,894	628,475	1,486,425	1,486,425	1,391,216
2009	625,582	625,582	684,377	1,363,956	1,363,956	1,399,667
2010	663,009	663,009	740,280	1,364,483	1,364,483	1,408,117
2011	1,009,688	1,009,688	796,183	1,383,401	1,383,401	1,416,568
2012	1,108,856	1,108,856	852,086	1,375,477	1,375,477	1,425,018
2013	952,380	952,380	907,989	1,385,427	1,385,427	1,433,469
2014	791,846	791,846	963,892		1,435,643	1,441,920
2015	989,658	989,658	1,019,795		1,442,838	1,450,370
2016		1,075,698	1,075,698		1,450,033	1,458,821
2017		1,131,601	1,131,601		1,457,229	1,467,271
2018		1,187,504	1,187,504		1,464,424	1,475,722
2019		1,243,407	1,243,407		1,471,619	1,484,173
2020		1,299,310	1,299,310		1,478,815	1,492,623
2021		1,355,213	1,355,213		1,486,010	1,501,074
2022		1,411,116	1,411,116		1,493,205	1,509,524
2023		1,467,019	1,467,019		1,500,400	1,517,975
2024		1,522,922	1,522,922		1,507,596	1,526,426
2025		1,578,824	1,578,824		1,514,791	1,534,876
2026		1,634,727	1,634,727		1,521,986	1,543,327
2027		1,690,630	1,690,630		1,529,181	1,551,777
2028		1,746,533	1,746,533		1,536,377	1,560,228

2029		1,802,436	1,802,436		1,543,572	1,568,679
2030		1,858,339	1,858,339		1,550,767	1,577,129

Figure 2.2.1 shows an actual traffic profile in 2009 within a 250-NM radius coverage of Tagaytay radar. The profile shows that traffic volume is concentrated at the NAIA airport. While flight and traffic movement has grown since 2009, the fact remains that the rest of the Manila FIR is not congested. Also, the build-up of traffic in the airspace of Metropolitan Manila is not an issue of the surveillance system but the configuration of the aerodrome and the design of the runways. As shown in Figure 2.2.2, the elevation view of the traffic profile shows the movement in the aerodrome.

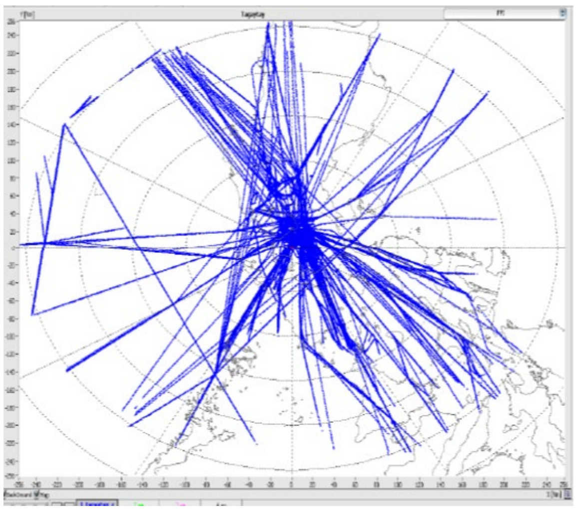


Figure 2.2.1 Actual Traffic Profile within a 250 NM Radius Coverage of Tagaytay radar

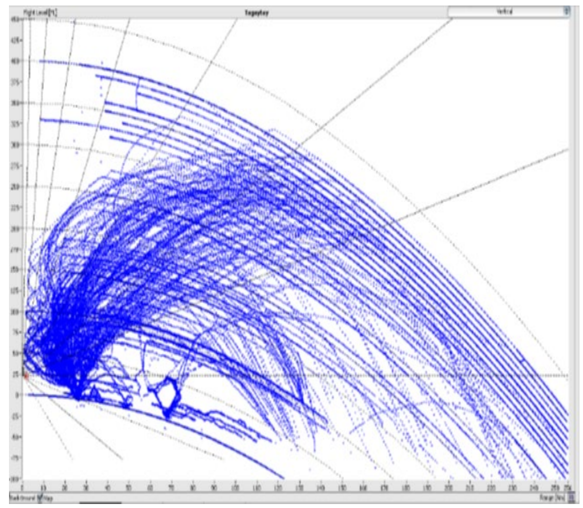


Figure 2.2.2 Philippines Actual Traffic Profile in 2009

The radars within the CNS/ATM Project are Mode S radars but have no ADS-B reception capability. Table 2.2.3 shows the capabilities of the radars, coverage and usage: (source: CAAP). Tagaytay radar is capable of ADS-B transmission processing. Since its operation in 2009, data recording of the ADS-B signal is available.

Table 2.2.3 Radar Capability in the Philippine Airspace (CAAP, 2016)

Location	Coverage	Radar Type	Year Installed
Clark	110NM	ASR/MSSR	2006
Manila App	60NM	ASR/SSR Mode S	Old: 2001
			New: 2017*
Kalibo App	60NM	ASR/SSR Mode S	2017*
Bacolod App	60NM	SSR Mode S	2017*
Mactan App	180NM	ASR/SSR Mode S	Old: 1987
			New: 2017*
Davao App	60NM	SSR Mode S	2017*
Laoag	250NM	SSR Mode S	2017*
Aparri	250NM	SSR Mode S	2017*
Tagaytay	250NM	SSR Enhanced Mode S**	2009
Palawan	250NM	SSR Mode S	2017*

Mt. Majic	250NM	SSR Mode S	Old: 1996
			New: 2017*
Zamboanga	250NM	SSR Mode S	2017*

*Under CNS/ATM Project
**Enhanced Mode S with ADS-B reception capability

3. Results and Discussion

The ANSP regulatory unit of the Civil Aviation Authority of the Philippines – Aerodrome Air Navigation Safety Oversight Office (AANSOO) – has issued Memorandum Circulars (MC 18-14 and MC 19-14) regarding Acceptance of ATM Safety Management System and Regulation of Air Traffic Service SMS and ATS Units-Facilities (Civil Aviation Authority of the Philippines, 2014). but there are no regulatory or guidance documents about the safety assessment of surveillance system. The Air Navigation Service unit acting as an ANSP also doesn't have a safety assessment document before the intended installation of ADS-B since 2015.

Looking into the Authority's plan, there are no documented safety assessment or safety case prepared for the ADS-B implementation. The budget was allocated since 2015 for the installation of the ADS-B equipment in three sites. However, the documented objective of the use of installation is unclear. Hence, it is understandable that regulation to enforce the requirements necessary for meeting the objective can hardly be defined.

The Flight Standard and Inspectorate Service (FSIS) of the CAAP is the regulatory unit responsible for aircraft registration and avionics requirement. Since the operations concept and regulation for ADS-B requirements are not defined or documented, aircraft equipage certification, monitoring and control are consequently undefined.

The Philippine airspace (Manila Flight Information Region – otherwise known as the Mla FIR) covers approximately 3 million km2 (Terahara, 2012) or 1.158 million square miles area (airspace covering 809,967 square NM). Based on the available data from 2008 – 2010, aircraft movement comparison between NAIA Airport and EWK Airport in New York has a daily average of 618 (Japan Airport Consultants Inc., 2011) and 1,162 flights (The Port Authority of NY & NJ, 2013) respectively. On a regional comparison, NCR (NAIA, DMIA, Subic, and Plaridel) and New York/Jersey have a daily average of 951 and 3,903 flights respectively. In Europe, London Heathrow Airport has roughly 1,300 daily flights in May 2016 (London Heathrow Airport, 2016). This reflects the traffic density in the Philippines compared to the U.S. and the United Kingdom. Very high traffic density is the primary reason to implement ADS-B. And separation reduction is the most tangible benefit only if the safety level is maintained.

Table 3.1 shows the summary of baseline gaps of the Philippine surveillance program in comparison with that of FAA and Eurocontrol. It is imperative to address the gaps to determine the condition of the traffic and the requirements of airspace users and other stakeholders. These gaps are also needed to move on with the necessary preparation needed in the planning and implementation of ADS-B. It will affect a lot of systems and activities that would render a mere procurement of ground station unusable not to mention the risk exposure of many airspace users.

ADS-B is a satellite-based surveillance technology, which needs the integration of several different new and old in the current radar environment. These are the infrastructure in the space segment (e.g. GNSS, SBAS, RAIM, avionics); infrastructure in the ground (e.g. ADS-B sensor, GNSS monitoring, ATC automation); pilot/flight crew and air traffic controller skill; operation performance and aviation systems standards; safety and separation model and standards; interoperability requirements; procedures; certification standards; regulations; monitoring and control.

FAA intends to implement ADS-B NAS-wide. As the sole air navigation service provider and regulator, airspace affected include classes A, B, C, and E. Original plan is to implement ADS-B Out and In to maximize the benefit; nonetheless, ADS-B In operational requirements is still developing and early equipage would be very costly to operators. The 2010 Final Rule only mandates operations performance requirements about ADS-B Out with a voluntary option to prepare avionics with ADS-In capability. Experimental and trial evaluation subsidized by FAA was implemented in selected areas where radar installation is difficult like in Juneau, Alaska; Gulf of Mexico; Ohio;

and Houston, Texas. Trial implementation mainly uses multilateration to ensure safety. Thus, until 2035 the surveillance system of FAA would be a mixture of radar, multilateration, and ADS-B.

Table 3.1 Baseline Gap on Surveillance Program

Baseline Items	Reference	FAA	Eurocontrol	Philippines
Surveillance model for ATC based on traffic demand	Availability and/or application of model to determine policy on surveillance requirement	YES	YES	NONE
Traffic demand analysis	Traffic data structure, collection and traffic segmentation	YES	YES	NONE
Mode S radar	Coverage	150 Enroute Radars + Terminal Radars in 40 aerodromes	Well covered continental airspace up to Level 5	6 Enroute + 6 Terminal Radars; cover 100% continental and 80% of FIR
Modes S equipage	Aircraft population equipped w/ Mode S	Combination of Mode S and UAT transponders but all are required to have either or both	Mode S transponder equipage is required to all aircrafts	No policy, mandate or regulation for the use of Mode S transponder
Mode S address management	Fundamentally sound Mode S address management system	Very thorough Aircraft registry information system is well maintained	Europe-wide information system is existing	No rules and regulation to deter Mode S address and registry conflicts
Mode S radar w/ ADS-B capability	For ADS-B-equipped aircraft monitoring and analysis	Different approach. Start w/ multilateration	POEMS program participated by some EU states (e.g BeNeLux)	1 of 6 enroute radars has ADS-B capability
GNSS monitoring	Service quality and risk mitigation system	Available	Available	None
GNSS augmentation	Safe and secure SBAS	Own WAAS	Own EGNOS	None
ADS-B Study / Research	Documented study / research	Available	Available	None
ADS-B-based data set requirements	Data set requirement Identified	YES	YES	NO
ADS-B applications	Specific or extent of application identified	YES	YES	NO

With the organization structure of Eurocontrol, member States decided on ADS-B implementation. Eurocontrol's role is to do the necessary research; standards documentation together with Eurocae; safety case guidelines preparation; safety assessment and risk analysis; testbed design and evaluation standards/procedures formulation to cater to their member States.

The regulation applies to all flights operating as general air traffic per instrument flight rules within the airspace provided for in Article 1(3) of Regulation (EC) No 551/2004 of the European Parliament and the Council except Articles 7(3) and 7(4) which shall apply to all flights operating as general air traffic (European Commission, 2011).

3.1 FAA and Eurocontrol Equipment and Technology Upgrade

FAA will continue to use the existing 150 radars for en route, other terminal radars in 40 locations, and multilateration while ADS-B installation is completed in 2013. The upgrade of the ATC automation system all over the NAS supports the Final Rule mandate in January 2020. The Final Rule laid down the affected airspace with few exceptions; operational and system requirements; performance requirements on the system, transmit power, latency, time to indicate accuracy and integrity changes, availability, continuity, TIS-B; specific quality indicators based on DO-260B; interface of two (2) links (i.e. UAT and 1090ES); broadcast message elements; ability to turn-off ADS-B Out transmissions; existing equipment requirements (e.g. Mode S transponders, TCAS); program implementation timeline, financial/operational incentives; safety; efficiency; ADS-B In application, international harmonization; backup ATC surveillance; privacy; security; ADS-B equipment scheduled maintenance; specific design parameters; and economic issues. Separation standards and models are going to target 3NM throughout the NAS.
The FAA regulations final rule on ADS-B Performance Requirements is effective 11 August 2010 for compliance on 1 January 2020. The EU Regulation No. 1207/2011 as of 22 Nov 2011 lays down requirements for the performance and the interoperability of surveillance for the single European sky. This includes the following: performance requirements; interoperability requirements; spectrum protection; associated procedures; state aircraft; safety requirements; conformity or suitability for use of constituents; verification of systems; additional requirements; exemptions on the cooperative surveillance chain; exemptions of aircraft; and, entry into force and application. Since the surveillance program of the EU has been carried out in detail of different infrastructure, avionics, models, and procedures to make sure minute requirements are standardized among the 37 member states. EU latest standard equivalent to DO-260B is the ED-102A

Policy for ADS-B implementation in Europe will use 1090 MHz Extended Squitter as the preferred initial technology in line with the recommendations made at ICAO ANC-11. It uses transponders that are already on-board aircraft through the Mode S and TCAS mandates for the European airspace, thus minimizing investment for airlines. The 1090 MHz Extended Squitter is fully compatible with other ADS-B technology decisions made in the United States, Canada, and Australia, ensuring global interoperability for commercial aircraft. Local implementations of ADS-B using VDL Mode 4 will also happen, however, these must respect the requirement for interoperability with 1090 Extended Squitter where necessary.

The Policy for ADS-B implementation in Europe is to deploy ADS-B voluntarily by navigation service providers, in consultation with their main customers, to satisfy a local or regional operational surveillance requirement. Eurocontrol will do everything necessary to co-ordinate trials and have all the standards, certification material, safety, and business cases in place to support implementation. It is expected that this will lead to the following: Implementation of ADS-B in Europe will start by using ADS-B in support of Ground Surveillance applications ("ADS-B Out"). In the medium term, based on the availability of capable aircraft, these Ground Surveillance applications will be followed by the use of ADS-B for Airborne Surveillance applications requiring air-to-air communications ("ADS-B-In"). Initial applications will be for Airborne Traffic Situational Awareness (ATSAW) followed by more complex spacing applications, such as the In Trail Procedure (ITP).

3.2 Eurocontrol ADS-B Implementation Policy

ADS-B enables several new techniques and applications for Air Traffic Control in response to the growing safety demands and unrelenting growth in air traffic in Europe. As a key enabler of the plan to address these future requirements, ADS-B within the EUROCONTROL ATM 2000+ Strategy supports the objectives of improved safety, capacity, efficiency, and environmental sustainability (Eurocontrol Cascade, 2006). The Eurocontrol Surveillance Strategy has three main pillars: Primary and secondary radar; ADS-B and, Multilateration. These use different surveillance techniques but are complementary to each other. Any choice of surveillance techniques or a combination of techniques must be made based on the operational surveillance needs, encompassing both airborne and ground aspects, and will be influenced by the environment and cost-benefit considerations.

Perhaps the biggest attraction of installing a surveillance infrastructure based on ADS-B is that the ground stations can be provided at a fraction of the cost of conventional rotating radars. Even then, Eurocontrol still has to consider all systems that will be affected such as the primary concern in aviation – safety.

Safety assessment made by Eurocae relative to the Safety, Performance, and Interoperability Requirements Document for ADS-B-NRA Application using Fault Tree Analysis is demonstrated by Eurocae on ED126 (European Organisation for Civil Aviation Equipment, 2005). Eurocontrol was very prudent and scientific in the conceptualization, research, planning, and implementation of their surveillance programs. The transition of technology in the surveillance domain for the whole of Europe has been based on reliable air traffic data region-wide. Their move over traffic forecast increase is carefully founded on scientific research and partnership which developers and aviation products/equipment manufacturers (e.g., academe, aircraft, and CNS/ATM equipment/systems manufacturers). They have traffic-infrastructure and human factors-system modeling. They can measure and determine whether the previous model has already reached its limits and hence they follow the same cycle of the process of program management for mitigation.

4. Conclusion

ADS-B would affect many system components and hence, the FAA safety certification process includes the aircraft, aircraft components, air traffic control systems, airports, aircraft operators, procedures, pilots, and air traffic controllers. These will be needed to complete safety requirements and will form part of the components needed in the adoption of ADS-B technology.

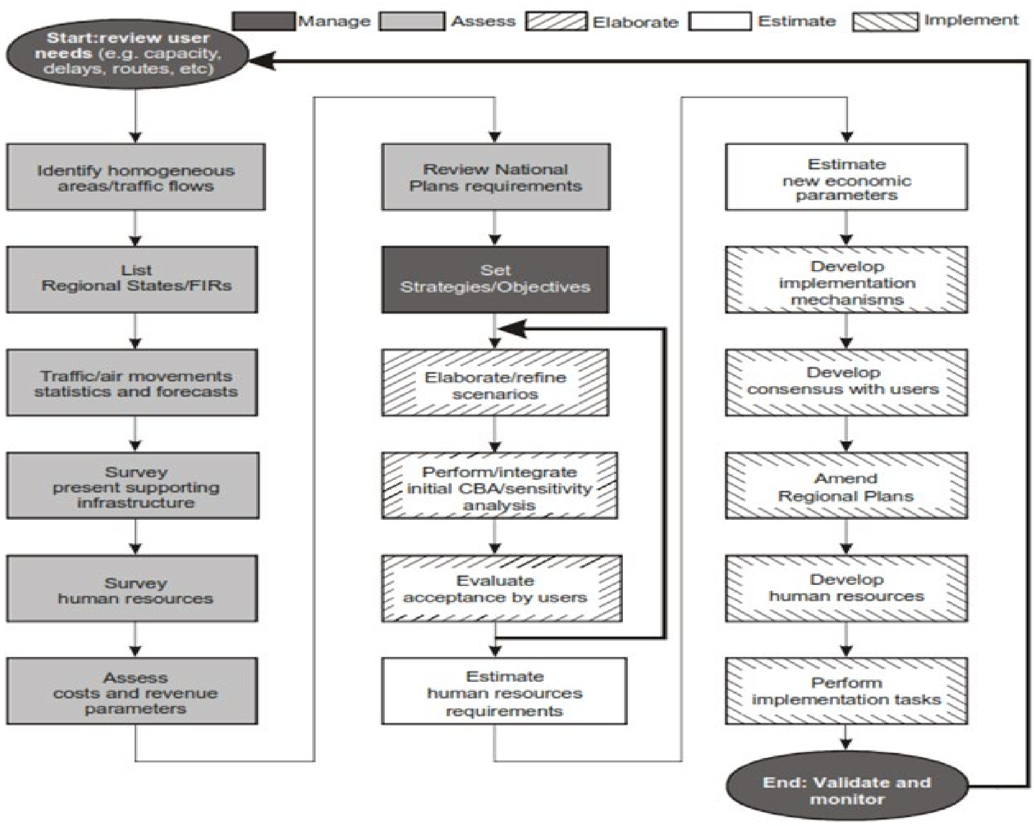
Traffic density in the Philippines is still low and the installation of new radars with enhanced coverage area/volume throughout the continental airspace is more than sufficient to meet current separation. As radar is still the cost-effective solution at present and shortly, the possibility of reducing aircraft separation from 10NM up to 5NM is still possible. Hence, there is no urgency to introduce ADS-B in the near term. The period between now and the traffic forecast that will get close to New York/New Jersey statistics (sometime in 2030), can be used to fill the gaps and prepare for the implementation of ADS-B for the long term. The availability of ADS-B data from Tagaytay Radar recordings can be a useful means to monitor and evaluate ADS-B signals without forcing airspace users to equip nor incurring a lot of up-front cost in infrastructure. Also, at the same time, there will be no disruption in any part of the surveillance and ATM systems.

The studies made and the implementation approach of FAA and Eurocontrol on ADS-B could then be adopted as appropriate to the intended application as a gauge in the evaluation of available ADS-B records and traffic profile from all other radars. Any further development in ADS-B avionics will not have an adverse impact on the Philippine surveillance system much less on cost. While the ADS-B technology matures, the Philippines will be in a better position to make a seamless transition as the cost will decrease and benefits will increase.

CAAP can make use of the data recordings in Tagaytay Mode S radar. There are at least eight and a half (8.5) years of ADS-B data to process, evaluate, and analyze the population of airspace users' equipage and performance. Obtain statistical data used for correlation with different safety- or security-related observations throughout those years. This may require high capacity analysis tools used in Europe or the U.S. The data structure in the ADS-B signal can give an idea of what data are needed in aircraft performance requirements and how it should be structured in a database for ADS-B operational certification of airspace users together with their fleet. Safety cases can be used to come up with a safety model. This safety model can, in turn, be a factor in determining the separation model, and consequently, the surveillance model can be determined as the operational concept is made clear. All these things will be contained in the regulation or rule on the ADS-B operational acceptance. Then the certification process can be designed. Option on SBAS requirement for radar performance equivalence can be that of Japan's Multi-functional Transport Satellite augmentation system. This however would need to be part of the avionics design for the Asia Pacific region. Cost-benefit analysis together with the business case should be undertaken to give airspace users economic and business impact foresight. Appropriate changes should be carried out in the automation system of the air traffic controller.

The baseline gap in surveillance domain operations and development programs in comparison with the U.S. FAA and EU Eurocontrol is quite huge. There is nonetheless no pressing traffic condition that should compel immediate requirement for new surveillance technology like the ADS-B to be mandated soon. With the additional radars being installed under the CNS/ATM Project, the current surveillance system for Manila FIR is sufficient to meet the current traffic demand and density in the medium and near-term forecast. The CAAP has a lot of work to do on data structure and information system to have a good accurate quantitative basis to start with. Surveillance, safety, and separation standard models of the current operation has to be determined. Once the demand is approaching the model limits, the process as contained in the ICAO document in Figure 4.1 can be followed.

Figure 4.1 ICAO Recommended Process



Study and implementation undertaken by the FAA and EU/Eurocontrol for ADS-B application can be a very good source of learning to adopt the application and avoid the costly mistakes. All affected subsystems including human factors among stakeholders in the surveillance domain and air traffic management should be taken into account. This would also include policies, regulations, and procedures. If the surveillance, safety, and separation models are clear, details can be readily incorporated in the implementing regulation.

In closing, with the current air surveillance configuration and the forecasted air traffic density in the Philippines, the shift to ADS-B system is rendered as compulsory but not too pressing that provides the opportunity for air navigation authorities and air space users to do capacity building and systems re-design in bridging the preparation & implementation gaps in the most economical way guided by the above-mentioned safety certification process and safety and separation models for ADS-B system shift.

References

CAAP. (2016, January 28). Electronic Aeronautical Information Publication of the Philippines. Manila. published.

Civil Aviation Authority of the Philippines. (2014). MC No. 18-14 Acceptance of ATM Safety Management Systems. Retrieved from http://caap.gov.ph/index.php/downloads/finish/27-mc-2014/372-mc-18-14-acceptance-of-atm-safety-management-system

Eurocontrol CASCADE. (2006). ADS-B Implementation Policy for Europe. 3

European Organisation for Civil Aviation Equipment. (2005, December). SAFETY, PERFORMANCE AND INTEROPERABILITY REQUIREMENTS DOCUMENT FOR ADS-B-NRA APPLICATION. SAFETY, PERFORMANCE AND INTEROPERABILITY REQUIREMENTS DOCUMENT FOR ADS-B-NRA APPLICATION. Cedex , Paris, France: Eurocae.

Japan Airport Consultants, Inc. (2011). Final Report 1 of 2 on Study on the Airport Strategy for Greater Capital Region in Philippines. Retrieved from http://open_jicareport.jica.go.jp/pdf/12068722_01.pdf

Japan. (2003). Capacity Enhancement Over The North/Central Pacific Areas. Eleventh Air Navigation Conference (p. 6). Montreal: *ICAO AN-Conf/11-WP/168.*

London Heathrow Airport. (2016, May). Aircraft Movement Archive page. Retrieved from http://www.lhr-lgw.co.uk/archive-main-munu.html

Terahara, G. (2012). Philippines Nationwide Air Navigation Facilities Modernization Project Phase III. Japan International Cooperation Agency. JICA. Retrieved from http://www.jica.go.jp/english/our_work/evaluation/oda_loan/monitoring/c8h0vm000001rdlp-att/2011_full_04.pdf

The Port Authority of NY & NJ. (2013). Airport Traffic Report. Retrieved from https://www.panynj.gov/airports/pdf-traffic/ATR2013.pdf

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