TP 12930E
APEC Transportation Safety and Security Project
Satellite Navigation and Communications

Element 1 - Inventory of Existing and Planned
SN&C Systems in the APEC Economies
Part 2: Implementation Plans

Prepared for
Transportation Development Centre
Safety and Security
Transport Canada

by
Hickling Corporation

January 1997

Authors:
Heather Roy
David Low

This report reflects the views of the authors and not necessarily those of the Transportation Development Centre.

Project Team

David Arthurs

David Low

Heather Roy

Un sommaire français se trouve avant la table des matières.

Transport Canada | Transports Canada

PUBLICATION DATA FORM

1. Transport Canada Publication No.	2. Project No.	3. Recipient's Catalogue No.
TP 12930E	8860	

4. Title and Subtitle	5. Publication Date
APEC Transportation Safety & Security Project Satellite Navigation and Communications Element 1 - Inventory of Existing and Planned SN&C Systems in the APEC Economies Part 2: Implementation Plans	January 1997
	6. Performing Organization Document No.
7. Author(s)	8. Transport Canada File No.
Heather Roy, David Low	ZCD1450-183-1
9. Performing Organization Name and Address	10. PWGSC File No.
Hickling Corporation 350 Sparks Street, 6th Floor Ottawa, Ontario K1R 7S8	XSD95-00169-(621)
	11. PWGSC or Transport Canada Contract No.
	T8200-5-5536/01-XSD
12. Sponsoring Agency Name and Address	13. Type of Publication and Period Covered
Transportation Development Centre (TDC) 800 René Lévesque Blvd. West 6th Floor Montreal, Quebec H3B 1X9	Final
	14. Project Officer
	S. Ling Suen

15. Supplementary Notes (Funding programs, titles of related publications, etc.)

APEC Transport Working Group - Safety and Security Project.
One of a series of reports produced on Satellite Navigation and Communications.

16. Abstract

Canada is a member of the Asia-Pacific Economic Cooperation (APEC) which comprises 18 economies: Australia, Brunei Darussalam, Canada, Chile, the People's Republic of China, Chinese Taipei, Hong Kong, Indonesia, Japan, the Republic of Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, the Republic of the Philippines, Singapore, Thailand and the United States. In support of APEC, Transport Canada undertook a study of the implementation of satellite navigation and communications (SN&C) for both air and marine. This study consists of the following elements:

- Element 1 - Inventory of Existing and Planned SN&C Systems in APEC economies;
- Element 2 - SN&C Technology and Safety Review; and
- Element 3 - Costs and Benefits of SN&C for Air and Marine Transportation.

This report presents the results of Part 2: Implementation Plans of Element 1, and covers in particular:

- The data collection process used to obtain the necessary information and data from the eighteen economies.
- An introduction to the findings on the economies' plans for the implementation of satellite-based air and marine navigation and communication systems.
- An assessment of actual or anticipated implementation issues and the scope seen for concerted action by authorities in the APEC economies to overcome these problems.
- Conclusions.

17. Key Words	18. Distribution Statement
Air navigation, marine navigation, APEC, DGPS, air traffic management, vessel traffic services	Limited number of copies available from the Transportation Development Centre

19. Security Classification (of this publication)	20. Security Classification (of this page)	21. Declassification (date)	22. No. of Pages	23. Price
Unclassified	Unclassified	—	xliv, 58, apps	—

CDT/TDC 79-005
Rev. 96

Canada

Transports Canada Transport Canada

FORMULE DE DONNÉES POUR PUBLICATION

1. Nº de la publication de Transports Canada
TP 12930E

2. Nº de l'étude
8860

3. Nº de catalogue du destinataire

4. Titre et sous-titre
APEC Transportation Safety & Security Project
Satellite Navigation and Communications
Element 1 - Inventory of Existing and Planned
SN&C Systems in the APEC Economies
Part 2: Implementation Plans

5. Date de la publication
Janvier 1997

6. Nº de document de l'organisme exécutant

7. Auteur(s)
Heather Roy, David Low

8. Nº de dossier - Transports Canada
ZCD1450-183-1

9. Nom et adresse de l'organisme exécutant
Hickling Corporation
350 Sparks Street, 6th Floor
Ottawa, Ontario
K1R 7S8

10. Nº de dossier - TPSGC
XSD95-00169-(621)

11. Nº de contrat - TPSGC ou Transports Canada
T8200-5-5536/01-XSD

12. Nom et adresse de l'organisme parrain
Centre de développement des transports (CDT)
800, boul. René-Lévesque Ouest
6e étage
Montréal (Québec)
H3B 1X9

13. Genre de publication et période visée
Final

14. Agent de projet
S. Ling Suen

15. Remarques additionnelles (programmes de financement, titres de publications connexes, etc.)
Groupe de travail de l'APEC chargé des transports - Project Sûreté et Sécurité.
Un des rapports réalisés sur les systèmes de navigation et de communications par satellite.

16. Résumé

Le Canada est membre de l'APEC (Organisation de la coopération économique Asie-Pacifique), qui comprend les 18 pays suivants : Australie, Brunei Darussalam, Canada, Chili, République populaire de Chine, Chine de Taipei, Hong Kong, Indonésie, Japon, République de Corée, Malaisie, Mexique, Nouvelle-Zélande, Papouasie-Nouvelle-Guinée, République des Philippines, Singapour, Thaïlande et États-Unis. À l'appui de l'APEC, Transports Canada a entrepris une étude sur la mise en oeuvre de systèmes de navigation et de communications par satellite (NCS) pour l'aviation et la marine. Cette étude comporte les éléments suivants :

- Élément 1 - Inventaire des systèmes actuels et prévus de NCS dans les pays de l'APEC;
- Élément 2 - Examen de la technologie et de la sécurité des systèmes NCS;
- Élément 3 - Coûts et avantages des systèmes NCS pour les transports aériens et maritimes.

Dans le présent rapport, on retrouve les résultats de la partie 2 : Plans de mise en oeuvre, de l'élément 1, notamment :

- le processus de collecte des données qui a servi à obtenir les renseignements et les données nécessaires auprès des 18 pays;
- les constatations de l'examen des plans de ces pays pour la mise en oeuvre de systèmes de navigation et de communications aériennes et maritimes par satellite;
- l'évaluation des problèmes réels ou prévus de la mise en oeuvre et la portée envisagée de mesures concertées de la part des autorités des pays de l'APEC pour surmonter les problèmes;
- les conclusions.

17. Mots clés
Navigation aérienne, navigation maritime, APEC, DGPS, gestion de la circulation aérienne, services du trafic maritime

18. Diffusion
Le Centre de développement des transports dispose d'un nombre limité d'exemplaires.

19. Classification de sécurité (de cette publication)	20. Classification de sécurité (de cette page)	21. Déclassification (date)	22. Nombre de pages	23. Prix
Non classifiée	Non classifiée	—	xliv, 58, ann.	—

CDT/TDC 79-005
Rev. 96

Canada

Related APEC Transportation Safety & Security Project Reports

<u>TP 12928</u> APEC Transportation Safety & Security Project
Satellite Navigation and Communications
Summary Report for Study Elements 1, 2 and 3

<u>TP 12929E</u> APEC Transportation Safety & Security Project
Satellite Navigation and Communications
Element 1 - Inventory of Existing and Planned
SN&C Systems in the APEC Economies
Part 1: Trade, Traffic and APEC

<u>TP 12930E</u> APEC Transportation Safety & Security Project
Satellite Navigation and Communications
Element 1 - Inventory of Existing and Planned
SN&C Systems in the APEC Economies
Part 2: Implementation Plans

<u>TP 12931E</u> APEC Transportation Safety & Security Project
Satellite Navigation and Communications
Element 2 - SN&C Technology and Safety Review
in the APEC Economies
Part 1: Technology Review

<u>TP 12932E</u> APEC Transportation Safety & Security Project
Satellite Navigation and Communications
Element 2 - SN&C Technology and Safety Review
in the APEC Economies
Part 2: Safety Review

<u>TP 12933E</u> APEC Transportation Safety & Security Project
Satellite Navigation and Communications
Element 3 - SN&C Costs and Benefits Assessment
in the APEC Economies

Executive Summary

INTRODUCTION

APEC Satellite Navigation and Communications Study

The Asia-Pacific Economic Cooperation (APEC) comprises 18 economies: Australia, Brunei Darussalam, Canada, Chile, the People's Republic of China, Chinese Taipei, Hong Kong, Indonesia, Japan, the Republic of Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, the Republic of the Philippines, Singapore, Thailand, and the United States. These economies have agreed to cooperate in four areas: global and regional economic development, global trade liberalization, and regional cooperation in specific sectors. One of the sectors identified is transportation. The Transportation Working Group (TPT/WG) was created to coordinate that effort.

The ambitious agenda for liberalizing trade in the region will bring about a rapid increase in air and marine traffic and a requirement for higher levels of aircraft and shipping throughput. This demand for increased capacity is driving the application of satellite communications, navigation and surveillance technologies and systems. It is apparent from discussions in the TPT/WG that the economies of APEC share an interest in introducing new technologies and systems in a way that maintains or improves transportation safety.

The Canadian Minister of Transport has made a commitment to APEC Ministers of Transportation to lead the promotion of transport system safety in the APEC region. To that end, Transport Canada proposed a study on the implementation of satellite navigation and communications (SN&C) for both of air and marine. The study is a component of the APEC Action Program in Transportation.

The study consists of the following elements:

- Element 1 - Inventory of Existing and Planned Satellite Navigation and Communications Systems in the APEC Economies;
- Element 2 - Satellite Navigation and Communication Technology and Safety Review; and

- Element 3 - Costs and Benefits of Satellite Navigation and Communications for Air and Marine Transportation.

Hickling Corporation was contracted to carry out the work and detailed reports have been prepared and are available for each of the three elements. This report presents Part 2, Implementation Plans, of the final report for Element 1. A separate report presents the first part, Part 1: Trade and Traffic.

Part 2: Implementation Plans Report

This report presents the aviation and marine SN&C implementation plans for the APEC economies, Element 1 of the Study. In particular this report:

- Describes the data collection process used to obtain the necessary information and data to conduct the study;

- Introduces the findings on the economies' plans for the implementation of satellite-based air and marine navigation and communication systems;

- Assesses actual or anticipated implementation issues and the scope seen for concerted action by authorities in the APEC economies to overcome these problems; and

- Presents conclusions.

DATA COLLECTION

Process

Data was collected on the following five aspects of satellite navigation and communication for marine and air transportation in the APEC region: trade and traffic patterns, implementation plans and issues, SN&C technologies, safety, and economics. A four-stage approach to data collection was developed:

- Documentation Review - a thorough literature search was conducted to identify, compile and review documented information of SN&C technologies, systems, implementation plans and issues. Sources included the Internet, electronic library searches, the Transportation Development Centre (TDC), other government departments, the International Civil Aviation Organization (ICAO), the International Air Transport Association (IATA), and the International Maritime Organization (IMO).

- Data Collection Instruments - This stage involved the design of a consultation guide and accompanying data collection forms. The guide was used to structure the consultation process. It includes a description of the project and a series of questions and issues which were the focus of the interview.

- Contact List - In consultation with our team experts, the TDC scientific authorities, and other knowledgable sources, a list of contacts in the APEC economies, ICAO, IMO and other international agencies was developed. This list provided the starting point for the consultation process.

- Consultations - Consultations were arranged and conducted with the economy representatives to the APEC TPT/WG and other international agencies such as ICAO, IMO and INMARSAT. Information was collected by telephone, fax, E-mail and personal interviews.

Results

Contacts were made with the APEC TPT/WG members from all eighteen of the economies. Responses to the consultation guide and the applicability of supplemental information provided have been varied. All told, fifteen of the eighteen economies responded for their aviation sector by either filling out the questionnaire and/or sending documentation; while nine responded for marine. Data was then collected from other sources such as articles, home pages on the Internet and second-party documents to provided information for all but one economy in the aviation sector and four in the marine sector. Table 1 presents a summary of the data collected from each of the economies.

As can be seen from Table 1, complete data (i.e., detailed implementation plans, responses to consultation guide, supporting documentation) for the aviation sector were collected from eleven of the eighteen economies, for the marine sector from eight economies. Basic data (i.e., less detailed implementation plans, no or sketchy response to consultation guide, minimal documentation) have been collected for aviation from four economies; and marine, three economies. Finally, minimal data (i.e., no implementation plan, no or limited response to consultation guide, little or outdated supporting documentation) have been collected from two economies for aviation and two for marine. Economy reports were prepared from the available documentation and submitted to the economies for their review and comment.

Table 1: Summary of Data Collection Results by Economy

Economy	Sources of Marine Information			Sources of Aviation Information			Data Completeness		Economy Report Comments Received	
	Interview	Guide	Docmn't	Interview	Guide	Docmn't	Marine	Aviation	Marine	Aviation
Australia	✔		✔	✔		✔	●	●	✔	✔
Brunei	No data was available				✔		None	▲		
Canada	✔		✔			✔	●	●	✔	✔
Chile	No data was available				✔		None	▲		✔
China			✔			✔	■	■		
Chinese Taipei		✔			✔		●	●		
Hong Kong			✔		✔	✔	▲	●		
Indonesia	No data was available					✔	None	■		
Japan			✔			✔	▲	▲	✔	✔
Korea	No data was available				✔		None	●		✔
Malaysia		✔			✔		●	●		
Mexico			✔		✔	✔	■	●		✔
New Zealand	✔		✔	✔	✔	✔	▲	●		
PNG	No data was available									
Philippines	✔		✔		✔		●	●	✔	✔
Singapore	✔				✔	✔	●	●	✔	✔
Thailand	✔				✔	✔	●	▲	✔	✔
United States	✔		✔	✔		✔	●	●		

● **Completed Data** ▲ **Basic Data**
■ **Minimal Data**

IMPLEMENTATION PLANS

Summary of Economies' Aviation Plans

It is important to note that the following information on implementation plans is based on information that was collected from the economies and other sources of information between March and October of 1996. Given the rapid implementation of CNS/ATM in the region, this information may become outdated quickly. Also, implementation dates are based on the economies having initial operational capabilities and these may be available only on certain routes or in limited portions of an economy's airspace.

Nowhere in the world is the transition to CNS/ATM being accomplished more rapidly than the Asia-Pacific region. Not only have most of the economies developed their implementation plans for the transition to CNS/ATM, but many of them already have some elements of the CNS/ATM system operational. The following information describes the region's accomplishments and their future plans for implementing the key components of CNS/ATM.

Controller Pilot Data Link Capability (CPDLC)
The controller pilot data link capability (CPDLC) provides direct satellite/aircraft links allowing data and voice communications between the pilot and the controller. CPDLC is an integral component of CNS/ATM implementation. It is a requirement for Automatic Dependent Surveillance (ADS) and eventually will eliminate the need for HF communications. The economies are well on the way to having CPDLC available in the region. Australia, New Zealand, Singapore and the United States have satellite data link communications (based on the ARINC 622 communications - see ADS discussion). China will have initial operations of CPDLC in 1996 with Japan, Korea, Malaysia and Thailand following suit in 1997.

Automatic Dependent Surveillance (ADS) Implementation
Satellite navigation, communication and surveillance systems are not only being planned in the region but also implemented. In the South Pacific, current implementation of CNS/ATM systems is focussing on ADS. Today, ADS is operational in the oceanic airspaces of New Zealand, Australia, Singapore and the United; in the next two years it will become operational in China, Hong Kong, Japan and Thailand.

It is important to note that the ADS data link is accomplished via INMARSAT II Pacific Ocean Region Satellite (POR) and current implementation is based on the ARINC 622 specification (known as FANS-1) and does not meet the requirements of the Aeronautical Telecommunications Network (ATN). In order to obtain the major benefits associated with flexible routing and reduced separations as early as possible, it was decided to implement a system based on the ARINC 622 standard instead of waiting for the ATN Standards and Recommended Procedures (SARPS) which are currently under development. As a result, economies that have implemented early (i.e., Australia, New Zealand, Singapore, etc.) will have an ADS system based on FANS-1 architecture while economies that wait for the ATN SARPS (i.e., Canada) will have a different architecture.

Global Navigation Satellite System (GNSS)
Progress has also been made on the implementation of GNSS. Currently, the Global Positioning System (GPS) has been approved for en route use in Australia, Canada, New

Zealand and United States; approval is scheduled for Singapore in 1997. Significant work has also begun on the development of GPS overlays for non-precision approaches in Australia, Canada, Singapore and the United States.

The region is also evaluating the potential for a Regional Augmentation System (RAS). Japan is currently developing its Multi-functional Transport Satellite (MTSAT) which will be the backbone of the air-ground data/voice communication system. This system will provide a means for ADS and GNSS augmentation in the region. The current schedule indicates that the system will have initial operational capability in 1999. The United States has also begun development of an augmentation system known as the Wide Area Augmentation System (WAAS). WAAS will provide coverage over the continental United States, portions of Canada and the Pacific Ocean as far west as Hawaii. The system will have initial operational capability in 2000.

Australia is actively investigating the implementation of a wide area augmentation system. The economy has awarded a contract to undertake a GNSS augmentation systems audit and cost-benefit analysis for Australian civil aviation. Australia has also joined forces with New Zealand and the United States to develop an Augmentation Systems Test Bed (ASTB) in Australia during 1996/97. The aim of the ASTB is "to improve the integrity of GPS and GLONASS systems to support sole-means en-route, non-precision approach and, where the appropriate, differential corrections are provided, Category 1 precision approach requirements."

Aeronautical Telecommunications Network (ATN)
The ATN will provide for the interchange of digital data between a wide variety of end system applications supporting end users. Implementation of the ATN will allow for a seamless and global interchange of aeronautical information worldwide. It is an integral component of CNS/ATM and each economy needs to plan for its implementation. Only Australia, Canada, Chile, New Zealand, Singapore and the United States have set specific dates for their transition to the ATN. New applications are being defined so that the transition from Airlines Electronic Engineering Committee (AEEC) 622 Aircraft Communications Addressing and Reporting System (ACARS) standard to the ATN data exchange will require minimum redesign of existing applications. However, it is important that all economies include a transition time scale to the ATN in their implementation plans.

Summary of Economies' Marine Plans

As with the aviation implementation plans, the marine plans are based on information collected over a six-month period in 1996. As such, the information may not always represent the current state of implementation of SN&C technologies in the marine sector. Also, the information was based on data from only ten economies and may not provide a complete picture of SN&C implementation in the region.

Global Positioning System (GPS)/Global Navigation Satellite System (GLONASS)
Unlike aviation, there is less criticality to the signal availability, reliability and integrity of GPS/GLONASS (operational as of Jan. 18/96) for marine navigation. As a result, marine users have been able to incorporate the use of GPS for navigation without the immediate need of augmentation systems. This technology is available across the Asia-Pacific region and is used primarily by large commercial ships and other classes of vessels in ocean/offshore areas, where navigational hazards are not a significant factor, and accuracies of basic GPS/GLONASS are acceptable. It is also increasingly being used by smaller vessels, including recreational vessels, particularly in coastal and inland waterways, due to falling prices for receivers.

Differential GPS (DGPS)
In the marine mode, DGPS is largely used by large commercial ships in confined waterways, including ports, harbours, and harbour approaches. Other users include specialized marine activities including exploration and hydrographic services. Publicly provided DGPS is currently available in many areas of the United States, notably the coastal areas and in major inland waterways. In Canada, publicly-provided DGPS was made available in the summer of 1996 in coastal areas and in the Great Lakes/St. Lawrence waterway. Australia, China, Hong Kong and Singapore have implemented the beginnings of their DGPS networks.

Electronic Navigation Chart (ENC)/Electronic Chart Display Information System (ECDIS)
For some time now, commercial firms have realized the value and desirability of electronic charts that could be developed fairly simply from paper charts. As a result, there is a proliferation of "electronic charts" supplied by the private sector. However, the fact that commercially-developed data do not originate from a government authorized Hydrographic Organization (HO) means that the charts do not comply with IMO Performance Standards or the International Hydrographic Organization (IHO) data standard (S-57), and, therefore, cannot be used as a substitute for paper charts.

Private-public consortiums (e.g., such as that established in Canada) may lead to a faster overall delivery of S-57 data in the future. In the meantime, Canada, Japan, Singapore and the United States are the only APEC economies to have progressed significantly in the development of ENC data, although Australia and Hong Kong are committed to the near-term development.

The real value of ECDIS is in the ability to combine digitized charts with real-time navigational positioning such as that offered by GPS/DGPS. Major benefits may also be realized in the more frequent update of chart data. Based on the information collected, economies such as Canada and Japan put ECDIS to practical use with the IHO and IMO standards. Australia and the United States have been conducting operational trials of the system while Hong Kong is beginning their program to support ECDIS.

The IHO is responsible for the development of electronic chart standards that would complement the performance standards developed in cooperation with IMO and form the basis for the ECDIS system. A final (third) draft edition of the standard was announced in October, 1996. The IHO, through its Worldwide ENC Database (WEND) system has planned for ENC to be developed on a regional basis through Regional ENC Coordinating Centres (RENCs). At present, the Northern European RENC, based in Norway, is the only one to be established and is planning operational trials in late 1997. For the concept of RENCs to work, it is necessary for the RENCs to establish bilateral agreements with the individual HOs within the region, covering conditions for availability of data, and reimbursement for use. The Japanese Hydrographic Department has agreed to set up a RENC for East Asia and is discussing the formation with neighbouring countries.

SATCOM

The principle marine satellite communication system in use today is INMARSAT which as of 1995 provided marine communications to approximately 30 000 (or 25 percent) commercial or government ships around the world from four satellites placed to cover all the major oceans and seas. The number is growing dramatically and is expected to reach approximately 90 000 as soon as 1997.

Currently, the General Maritime Distress and Safety System (GMDSS) is a major element to the continuing implementation of satellite-based marine communications systems. In 1971, the IMO identified requirements and began development of the system that is referred to as GMDSS. Information from APEC consultations indicate that Rescue Coordination Centres (RCCs) have been established in Australia, Canada, the United States, Japan, Hong Kong and are being implemented in Singapore and Thailand. The Philippines will begin implementation within the next year. The implementation of GMDSS is of primary importance to economies that have not yet done so as the Safety of Life at Sea (SOLAS) convention requires implementation by 1999. As a result, GMDSS will be the focus of a number of economies over the next two years.

In addition to the medium, high and very high frequency radio systems, the majority of economies (for which data was available) have satellite communication capabilities. These services are provided by one or more of the many INMARSAT systems available for maritime use. Only the Philippines and Thailand do not currently have satellite communications but both economies are planning for these communications as part of their GMDSS programs.

Summary of Implementation Levels

Table 2 presents the levels of SN&C implementation that were assigned to each of the economies. The assignment of a high, medium or low level to an economy (in some instances a level such as medium to high was assigned) was based on the following criteria:

- Implementation of SN&C technologies to date;
- Involvement in development work and operational trials;
- Degree to which the SN&C technologies are to be implemented in the economy; and
- Schedule for implementation of the SN&C technologies.

IMPLEMENTATION ISSUES

As the Asia-Pacific region progresses toward satellite-based technologies, many concerns and issues regarding implementation have arisen which may potentially affect the timing and magnitude of the benefits and costs of SN&C implementation. Concerted efforts are being undertaken by ICAO and IMO to identify and address these issues. However, there may also be actions which APEC can take that will assist these international organizations in resolving these implementation and transition issues.

Sovereignty and Political Will
This is a critical issue for aviation but a lesser one for marine. The initial implementation of CNS/ATM has focussed attention on sovereignty issues. These include: the potential threat to revenues, jobs, and airspace and system "control"; and the need to find formulae for the sharing of facilities that safeguard the basic concerns of all economies. These sovereignty concerns differ according to economy and a regionally-based approach to overcome them is required. There is a need to establish the optimum number and location of facilities whether for satellite systems, reference and master stations or Air Traffic Control (ATC) services for the APEC region. From a marine perspective, the duplication of RENCs may also be affected by sovereignty concerns.

Table 2: Summary of SN&C Implementation Levels

Economy	Level of SN&C Implementation	
	Marine	Aviation
Australia	Medium High	High
Brunei Darussalam	na	Low Medium
Canada	High	High
Chile	na	Medium
China	Medium	High
Chinese Taipei	Low	Low
Hong Kong	Medium High	Medium High
Indonesia	na	Medium
Japan	na	High
Republic of Korea	na	Medium High
Malaysia	Medium	na
Mexico	na	Medium
New Zealand	Low	High
Papua New Guinea	na	na
Republic of the Philippines	Low	Low
Singapore	Medium	High
Thailand	Low	High
United States	High	High

na - Data not available to support assessment of level of implementation

National Security

With the move towards services such as navigation and satellite communications being provided by third parties, be they private or public, some economies fear that the level of authority and control over their airspace may be diminished.

Harmonization of Capabilities and Implementation Timing

In order to achieve the full impact of the SN&C technologies, it is critical that the APEC economies harmonize the capabilities of their systems, the timing of implementation and the application of standards and regulations to provide a seamless operating environment to the users.

Duplication of Equipment and Services

Whilst encouraging economies to consult with each other in harmonizing implementation of SN&C systems, it is also important, through advice and guidance, to persuade economies to collaborate in provision of systems and services to avoid duplication.

Coordination and Planning
In order to achieve the full benefits of the SN&C technologies, it is important that economies liaise with their neighbours and coordinate their implementation plans. Implementation plans need to be developed by all of the economies in the region to achieve harmonization of equipment and services, safety, efficiencies and cost-savings through compatibility between systems and avoidance of duplication.

Availability and Application of Standards/Regulations
The unavailability of standards/specifications may result in: the delay of SN&C implementation; the use of non-standard equipment or procedures; or the need to carry multiple types equipment to accomplish similar navigation and communication tasks in different areas of the region or in different regions. These may have possible safety, duplication, and cost implications, especially if the equipment is not upgradable to the approved standard.

Technical Assistance
Many economies have expressed an essential need for external technical support, and their preference for such support to be provided through ICAO. Technical assistance is required in a wide variety of areas including but not limited to: data link communications, ATN, ADS, airspace reorganization, certification, human factors and benefit-cost analysis. In some instances not only a transfer of knowledge may be desired, but personnel may be needed as many economies are occupied with upgrading the current terrestrial systems.

Costs/Funding Requirements
The implementation of SN&C technology will require significant investments in a number of areas including system development, procurement and installation of equipment, operations and maintenance and related transition costs such as training, work force adjustment, decommissioning and procedures development. Availability of funding is an issue for both the users and the economies, and is closely related to the costs of the implementation of SN&C and its ongoing operations.

Training
Economies have placed great emphasis on the importance of the identification of human resource requirements, management and training needs. This is especially the case with the introduction of the extremely complex SN&C technologies in avionics, ship bridges and control/monitoring stations. Assistance will be required for both the provision and financing of these activities.

User Acceptance
Many of the benefits of implementation will be governed by the acceptance of the technology by the transportation system users. The benefits to users that have promulgated the necessary SN&C investments are dependent on the proportion of users that have yet to adopt the technology. As a result, the full potential may not be achievable until a certain threshold

proportion of users are appropriately equipped. It may be worthwhile for the main beneficiaries to encourage some of the marginal users to equip.

POTENTIAL APEC ACTIONS

Encourage Support
The APEC TPT/WG brings together ministerial, political and technical individuals in a single forum. It is important that the political support be given to the organizations involved for, without political support, there will be limited commitment to SN&C. This forum could be used to stress the importance of providing support to individual economies as well as planning and implementation initiatives in the APEC region.

Coordination/Planning
Given the importance of coordination and planning to the implementation of SN&C technologies, another regional forum that could be used to assist with these activities may be beneficial. Regional implementation plans such as the APANPIRG plan could be reviewed to ensure that the economies are progressing as per the schedule.

Standards/Regulations
APEC could possibly support ICAO and IMO in their roles as developers of standards and/or regulations. In particular, APEC could provide support for the implementation of ICAO, IMO and industry standards throughout the region.

Technical, Funding and Training Assistance
There are three primary areas were APEC may be able to provide assistance to the SN&C implementation efforts:

- Technical - provide a forum for the dissemination of technical data and information;
- Funding - provide venues, funding and/or assist with funding arrangements for a variety of activities such as planning, education and training, WGS-84 implementation, etc.
- Training - provide assistance to international and regional organizations for training programs.

Information Exchange
APEC could provide a venue for the exchange of many kinds of data including technical data, implementation plans and schedules for both Asia-Pacific as well as other economies, and training programs and facilities.

CONCLUSIONS

Aviation Conclusions

Based on the information collected, the following conclusions were made regarding SN&C technologies in the areas of implementation plans, issues and potential APEC actions.

Implementation Plans

- By the year 2005, all member economies (for which information was available) will have either initiated implementation of or achieved operational use of the CNS/ATM system that they will be implementing.

- By the year 2005, wide area augmentation will be available throughout most of the region via such systems as Japan's MTSAT and/or the United States' WAAS.

- By the year 2000, CPDLC and ADS will be available throughout most of the oceanic airspace providing users with the significant benefits associated with flexible routing and reduced separations.

- Member economies have not all identified their plans for transition ATN as well as ADS-ATN; it is important that economies do so to ensure that coordination between the providers and the users is maintained resulting in an effective, efficient and beneficial transition for economies and users alike.

- The following levels of implementation were assigned to the economies:
  - **High** - Australia, Canada, China, Japan, New Zealand, Singapore, Thailand and the United States;
  - **Medium** - Chile, Hong Kong (Medium-High), Indonesia, Mexico and the Republic of Korea;
  - **Low** - Brunei Darussalam, Chinese Taipei and the Republic of the Philippines; and
  - No assessment - Malaysia and Papua New Guinea.

- The Asia-Pacific region has moved into the implementation and operational phase of CNS/ATM.

SN&C Implementation Issues

- Given the high level of response to this question, the identified key issues will likely be representative of the opinions of the member economies.

- The implementation issues that were of key concern to the economies who responded to the questionnaire were:
  - Harmonization and Seamlessness (6/13);
  - Standards and Regulations (5/13);
  - Cost and Funding (5/13);
  - Training (5/13);
  - User Acceptance (5/13); and
  - Coordination and Planning (4/13).

APEC Actions

- Given the high level of response to this question, the identified key APEC actions will likely be representative of the opinions of the member economies.

- The key potential APEC actions that were identified by the member economies were:
  - Funding Assistance (particularly in the area of training), (8/10);
  - Information Exchange (7/10);
  - Coordination and Planning (6/10); and
  - Encouragement and Support (4/10).

- Member economies did not indicate that APEC actions should focus on resolving the issue of availability of standards and regulations.

Marine Conclusions

Based on the information collected, the following conclusions have been made regarding SN&C technologies in the areas of implementation plans, issues and potential APEC actions. It is important to note that the following conclusions are based on data from only ten economies; and therefore, may not represent a complete picture of SN&C implementation plans in the region.

Implementation Plans

- Implementation of DGPS is progressing in the region as two economies have fully operational networks of DGPS and implementation is underway in four other economies.

- Implementation of ECDIS is progressing slowly in the region with only four economies currently using the technology; one other economy is beginning their program to support ECDIS.

- Availability of IMO S-57 ENC for the region may prove to be problematic as only four economies have progressed significantly in the development of ENC data although another two are committed to near-term development.

- Satellite communications are currently available in all but two of the eleven economies for which there was information available on communications capabilities.

- A number of APEC economies are currently focussing on implementation of GMDSS and not SN&C technologies such as DGPS and AIS.

- The following levels of implementation were assigned to the economies:
  - **High** - Canada and the United States;
  - **Medium** - Australia, China, Hong Kong (Medium-High), Malaysia (Medium-High), and Singapore;
  - **Low** - Chinese Taipei, New Zealand, the Republic of the Philippines, and Thailand; and
  - No assessment - Brunei, Chile, Japan, Indonesia, Mexico, Korea and Papua New Guinea.

- In general, implementation of marine SN&C technologies in the Asia-Pacific region is moving slowly.

SN&C Implementation Issues

- Given the low level of response to this question, the key issues may not be representative of the full APEC region.

- The key potential APEC actions that were identified by the member economies were:
  - Cost and Funding (4/5);
  - Standards and Regulations (3/5); and
  - Harmonization and Seamlessness (3/5).

APEC Actions

- Given the low level of response to this question, the key APEC actions may not be representative of the full APEC region.

The key potential APEC actions that were identified by the member economies were:

- Coordination and Planning (4/4);
- Funding Assistance (3/4);
- Standards and Regulations (3/4); and
- Technical Assistance (3/4).

Sommaire

INTRODUCTION

Étude de l'APEC sur les systèmes de navigation et de communications par satellite

L'APEC (Organisation de la coopération économique Asie-Pacifique) comprend 18 pays : Australie, Brunei Darussalam, Canada, Chili, République populaire de Chine, Chine de Taipei, Hong Kong, Indonésie, Japon, République de Corée, Malaisie, Mexique, Nouvelle-Zélande, Papouasie-Nouvelle-Guinée, République des Philippines, Singapour, Thaïlande et États-Unis. Ces pays ont convenu de coopérer dans les quatre domaines suivants: le développement économique mondial et régional, la libéralisation des échanges mondiaux, enfin, la coopération régionale dans certains secteurs, notamment les transports. Le Groupe de travail chargé des transports (TPT/WG) a été créé pour coordonner cette activité.

L'ambitieux programme de libéralisation du commerce dans la région entraînera une augmentation rapide du trafic aérien et maritime; il faudra donc améliorer la capacité des aéronefs et des navires. Cette demande de capacité accrue favorise le recours aux technologies et aux systèmes de communications, de navigation et de surveillance par satellite. Il ressort clairement des entretiens au sein du TPT/WG que les pays membres de l'APEC ont un intérêt commun dans l'introduction de nouvelles technologies et de nouveaux systèmes de façon à maintenir ou à améliorer la sécurité des transports.

Le ministre canadien des Transports s'est engagé envers ses homologues de l'APEC à mener la promotion de la sécurité des systèmes de transport dans la région. À cette fin, Transports Canada a proposé une étude sur la mise en oeuvre de systèmes de navigation et de communications par satellite (NCS) pour l'aviation et la marine. Cette étude fait partie du programme d'action de l'APEC en matière de transports.

Cette étude comporte les éléments suivants :

- Élément 1 - Inventaire des systèmes actuels et prévus de navigation et de communications par satellite dans les pays de l'APEC;

- Élément 2 - Examen de la technologie et de la sécurité des systèmes de navigation et de communications par satellite;

- Élément 3 - Coûts et avantages des systèmes de navigation et de communications par satellite pour les transports aériens et maritimes.

On a retenu les services de la société Hickling pour l'exécution des travaux. Chacun de ces derniers a fait l'objet d'un rapport détaillé qui est disponible. Dans le présent rapport, on retrouve la partie 2, Plans de mise en oeuvre, du rapport final de l'élément 1. La partie 1 : Échanges et trafic, est présentée dans un rapport séparé.

Partie 2 : Rapport sur les plans de mise en oeuvre

Le présent rapport contient les plans de mise en oeuvre des systèmes NCS pour l'aviation et la marine des pays de l'APEC, soit l'élément 1 de l'étude. Il traite notamment des questions suivantes :

- une description du processus de collecte des données qui a servi à obtenir les renseignements et les données nécessaires pour effectuer l'étude;

- les constatations de l'examen de ces plans des pays pour la mise en oeuvre de systèmes de navigation et de communications aériennes et maritimes par satellite;

- une évaluation des problèmes réels ou prévus de la mise en oeuvre et la portée envisagée de mesures concertées de la part des autorités des pays de l'APEC pour surmonter les problèmes.

- les conclusions.

COLLECTE DES DONNÉES

Processus

On a fait la collecte des données sur les cinq composantes suivantes de la navigation et des communications par satellite pour le transport maritime et aérien dans la région de l'APEC : tendances des échanges et du trafic, plans et questions de mise en oeuvre, technologies NCS, sécurité et facteurs économiques. On a élaboré une collecte des données en quatre étapes :

- Examen de la documentation - On a fait une recherche approfondie des publications spécialisées afin de cerner, de combiner et de passer en revue l'information documentée sur les systèmes, plans de mise en oeuvre et questions des technologies NCS. On a consulté notamment les sources suivantes : l'Internet, les recherches électroniques en bibliothèque, le Centre de développement des transports (CDT), d'autres ministères gouvernementaux, l'Organisation de l'aviation civile internationale (OACI), l'Association du transport aérien international (IATA) et enfin, l'Organisation maritime internationale (OMI).

- Instruments de collecte des données - À cette étape, on a élaboré un guide de consultation ainsi que les formules connexes de collecte des données. Ce guide a servi à structurer le processus de consultation. Il comprend une description du projet et une série de questions et de problèmes sur lesquels a porté l'entrevue.

- Liste des contacts - Avec le concours des experts de notre équipe, les autorités scientifiques du CDT et d'autres sources bien informées, on a dressé la liste des contacts externes (pays de l'APEC, OACI, OMI et autres organismes internationaux). Cette liste a constitué le point de départ du processus de consultation.

- Consultations - On a organisé et tenu des consultations avec les représentants des économies au Groupe de travail chargé des transports de l'APEC (TPT/WG), et à d'autres organismes internationaux comme l'OACI, l'OMI et l'INMARSAT. La collecte a été effectuée par téléphone, télécopieur et courrier électronique ainsi qu'au moyen d'entrevues.

Résultats

Des contacts ont été établis avec les représentants des 18 pays au sein du Groupe de travail. Ils ont donné des réponses variées au sujet du guide de consultation et de la pertinence des renseignements supplémentaires fournis. En tout, quinze et neuf représentants, sur 18, ont répondu pour leurs secteurs aviation et marine, respectivement; pour ce faire, ils ont rempli le questionnaire ou envoyé de la documentation. On a également consulté d'autres sources comme des articles, des pages d'accueil sur l'Internet et des documents de deuxième partie; on a ainsi obtenu des renseignements sur tous les pays sauf un dans le secteur aviation et quatre dans le secteur marine. Vous trouverez au tableau 1 un résumé des données obtenues sur chaque pays.

On peut voir au tableau 1 que des données complètes (c.-à-d. plans détaillés de mise en oeuvre, réactions au guide de consultation, documentation d'accompagnement) sur les secteurs aviation et marine ont été obtenues auprès de onze et de huit pays, respectivement, sur dix-huit. On a recueilli des données de base (c.-à-d. plans de mise en oeuvre moins détaillés, réactions inexistantes ou superficielles au guide de consultation, documentation minime) sur les secteurs aviation et marine de quatre et de trois pays, respectivement. Enfin, on a fait la collecte des données minimes (c.-à-d. aucun plan de mise en oeuvre, réactions inexistantes ou limitées au guide de consultation, documentation d'accompagnement mince ou désuète) sur les secteurs aviation et marine de deux pays. Les rapports sur les pays ont été préparés en fonction de la documentation disponible; ils ont été soumis aux gouvernements des dix-huit pays concernés pour examen et observations.

Tableau 1 : Tableau récapitulatif des résultats de la collecte des données, par pays

Pays	**Sources d'information sur le secteur marine**			**Sources d'information sur le secteur aviation**			**Intégrité des données**		**Observations reçues - rapport sur le pays**	
	Entrevue	**Guide**	**Doc.**	**Entrevue**	**Guide**	**Doc.**	**Marine**	**Aviation**	**Marine**	**Aviation**
Australie	✔		✔	✔		✔	●	●	✔	✔
Brunei Darussalam	**Données non disponibles**				✔		**Néant**	▲		
Canada	✔		✔			✔	●	●	✔	✔
Chili	**Données non disponibles**				✔		**Néant**	▲		✔
Chine			✔			✔	■	■		
Chine de Taipei		✔			✔		●	●		
Hong Kong			✔		✔	✔	▲	●		
Indonésie	**Données non disponibles**					✔	**Néant**	■		
Japon			✔			✔	▲	▲	✔	✔
Corée	**Données non disponibles**				✔		**Néant**	●		✔
Malaisie		✔			✔		●	●		
Mexique			✔		✔	✔	■	●		✔
Nouvelle-Zélande	✔		✔	✔	✔	✔	▲	●		
PNG	**Données non disponibles**									
Philippines	✔		✔		✔		●	●	✔	✔
Singapore	✔				✔	✔	●	●	✔	✔
Thaïlande	✔				✔	✔	●	▲	✔	✔
États-Unis	✔		✔	✔		✔	●	●		

● **Données complètes** ▲ **Données de base** ■ **Données minimes**

PLANS DE MISE EN OEUVRE

Sommaire des plans des différents pays à l'égard du secteur aviation

Soulignons que les renseignements ci-dessous sur les plans de mise en oeuvre ont été obtenus auprès des pays et d'autres sources d'information, de mars à octobre 1996. Compte tenu de l'implantation rapide du système CNS/ATM dans la région, ces renseignements pourraient être désuets sous peu. De plus, les dates de mise en oeuvre sont fondées sur les capacités opérationnelles initiales des pays, qui peuvent n'être offertes que sur certains trajets ou sur des portions limitées de l'espace aérien national.

Dans la région Asie-Pacifique, la transition au système CNS/ATM se déroule plus rapidement que partout ailleurs. Non seulement la plupart des pays ont élaboré leurs plans de mise en oeuvre pour la transition au système CNS/ATM, mais, dans nombre d'entre eux, certaines composantes du système sont déjà opérationnelles. On trouvera dans les paragraphes qui suivent une description des réalisations des pays de la région ainsi que les plans futurs de ceux-ci pour la mise en oeuvre des principales composantes de CNS/ATM.

Système de transmission de données contrôleur-pilote (CPDLC)
Ce système offre des liaisons directes entre le satellite et l'aéronef pour permettre les communications numériques et vocales entre le pilote et le contrôleur. Le CPDLC fait partie intégrante de la mise en oeuvre du CNS/ATM. Il est rendu nécessaire pour assurer la surveillance automatique par satellite (ADS); par la suite, il permettra d'éliminer la nécessité de communications HF. Les différents pays sont sur le point d'offrir le CPDLC dans la région. L'Australie, la Nouvelle-Zélande, Singapour et les États-Unis disposent de communications numériques par satellite (fondées sur les communications ARINC 622 - voir la discussion sur ADS). La Chine lancera le CPDLC en 1996; le Japon, la Corée, la Malaisie et la Thaïlande emboîteront le pas en 1997.

Mise en oeuvre de la Surveillance automatique par satellite (ADS)
Dans la région, les systèmes de navigation, de communications et de surveillance par satellite ne sont plus à l'étape de la planification mais de la mise en oeuvre. Dans le Pacifique Sud, l'implantation des systèmes CNS/ATM porte sur l'ADS. Aujourd'hui, l'ADS fonctionne dans les espaces aériens océaniques de la Nouvelle-Zélande, de l'Australie, de Singapour et des États-Unis; au cours des deux prochaines années, ce système deviendra opérationnel en Chine, à Hong Kong, au Japon et en Thaïlande.

Il est important de souligner que la liaison numérique ADS est assurée par l'intermédiaire du satellite de la région de l'océan Pacifique (ROP) INMARSAT II et que la mise en oeuvre actuelle est fondée sur la norme ARINC 622 (connue sous le nom de FANS-1) et qu'elle ne répond pas aux exigences du réseau de télécommunications aéronautiques (RTA). Afin de réaliser le plus tôt possible les avantages importants que permettent un tracé souple et une réduction des écarts, on a décidé de mettre en oeuvre un système fondé sur la norme ARINC 622 au lieu d'attendre la fin des travaux d'élaboration des normes et pratiques recommandées (SARPS) du RTA. Par conséquent, les pays qui ont procédé à une implantation rapide disposent d'un système ADS fondé sur l'architecture FANS-1 (c.-à-d. l'Australie, la Nouvelle-Zélande, Singapour et autres), tandis que d'autres pays (comme le Canada) qui attendent les SARPS du RTA auront une architecture différente.

Système mondial de navigation par satellite (SMNS)
Des progrès ont également été réalisés dans la mise en oeuvre du SMNS. À l'heure actuelle, on a approuvé l'utilisation, en cours de route, du Système de positionnement global (GPS) en Australie, au Canada, en Nouvelle-Zélande et aux États-Unis; Singapour devrait donner son aval en 1997. On a également commencé d'importants travaux de développement des cartes transparentes du GPS pour les approches de non-précision en Australie, au Canada, à Singapour et aux États-Unis.

La région évalue également les possibilités d'un système régional de renforcement des signaux (RAS). Le Japon construit actuellement son satellite multifonctionnel des transports (MTSAT) qui sera le fondement du système de communications numériques et vocales air-sol. Ce système permettra d'augmenter les capacités de l'ADS et du SMNS dans la région. Selon les plans actuels, le système entrera en activité en 1999. Les États-Unis ont également commencé l'élaboration d'un système de renforcement des signaux sur une grande étendue, appelé le Wide Area Augmentation System (WAAS). Ce dernier couvrira les états continentaux des États-Unis, certaines parties du Canada et l'océan Pacifique jusqu'à Hawaï vers l'ouest. Ce système entrera en activité en l'an 2000.

L'Australie examine attentivement la possibilité de mettre sur pied un système de renforcement des signaux sur une grande étendue. Ce pays a accordé un marché pour la vérification des systèmes de renforcement des signaux du SMNS ainsi qu'une analyse coûts-avantages pour l'aviation civile australienne. Ce pays a également joint ses efforts à ceux de la Nouvelle-Zélande et des États-Unis pour concevoir un banc d'essai des systèmes de renforcement des signaux (ASTB) en Australie, au cours de 1996-1997. L'ASTB a pour but d'améliorer l'intégrité des systèmes GPS et GLONASS pour appuyer, en cours de route, une approche de non-précision, par les seuls moyens du bord où, selon le cas, les écarts sont corrigés en fonction des exigences d'une approche de précision de catégorie 1.

Réseau des télécommunications aéronautiques (RTA)
Le RTA permettra l'échange de données numériques entre une grande diversité d'applications destinées aux utilisateurs. La mise en oeuvre du RTA assurera un échange ininterrompu de renseignements aéronautiques dans le monde entier. Il fait partie

intégrante du CNS/ATM et il incombe à chaque pays d'élaborer un plan de mise en oeuvre. Seuls l'Australie, le Canada, le Chili, la Nouvelle-Zélande, Singapour et les États-Unis se sont fixé une date précise pour la transition au RTA. On élabore actuellement de nouvelles applications afin de réduire au minimum la refonte des applications existantes lors de la transition de la norme 662 - Système d'échange de données techniques avion-sol en temps réel (ACARS), du Comité d'ingénierie électronique des compagnies aériennes (CIECA), à l'échange de données au moyen du RTA. Cependant, il est important que les différents pays prévoient dans leurs plans de mise en oeuvre une période de transition au RTA.

Sommaire des plans des différents pays à l'égard du secteur marine

Comme dans le cas des plans de mise en oeuvre pour le secteur aviation, les plans pour le secteur marine sont fondés sur les renseignements recueillis au cours d'une période de six mois, en 1996. Ces renseignements ne représentent donc pas toujours l'état actuel de la mise en oeuvre des technologies NCS dans le secteur marine. En outre, les renseignements étaient fondés sur des données en provenance de dix pays seulement; ils pourraient ne pas donner une image complète de l'implantation des technologies CNS dans la région.

Système de positionnement global (GPS) et Système global de navigation à satellites (GLONASS)

La disponibilité, la fiabilité et l'intégrité des signaux du GPS/GLONASS (en activité depuis le 18 janvier 1996) destinés à la navigation maritime sont moins cruciales que pour le secteur aviation. Par conséquent, les utilisateurs du secteur marine ont pu incorporer le GPS à leurs pratiques de navigation et ce, sans devoir se procurer immédiatement des systèmes de renforcement des signaux. Cette technologie est disponible dans l'ensemble de la région Asie-Pacifique; elle est utilisée surtout par les grands navires commerciaux et d'autres catégories de navires dans les secteurs océaniques et off-shore où les risques pour la navigation ne sont pas très importants; le niveau de précision GPS/GLONASS est alors acceptable. De plus en plus d'embarcations plus petites, notamment de plaisance, ont recours à ce système, en particulier dans les eaux côtières et intérieures, car le prix des récepteurs baisse constamment.

GPS différentiel (DGPS)

Dans le mode marine, le DGPS est utilisé surtout par de grands navires commerciaux dans des eaux confinées, y compris les ports, havres et approches de ceux-ci. Parmi les autres utilisateurs, on retrouve les services maritimes spécialisés qui s'occupent notamment d'exploration et d'hydrographie. À l'heure actuelle, le DGPS est fourni à titre de service public dans de nombreux secteurs des États-Unis, en particulier le long des côtes et des grandes voies d'eau intérieures. Au Canada, il a été offert à l'été de 1996 dans les secteurs côtiers ainsi que dans la région des Grands Lacs et de la Voie maritime du Saint-Laurent. L'Australie, la Chine, Hong Kong et Singapour ont commencé la mise en oeuvre de leurs réseaux DGPS.

Carte électronique de navigation (CEN) et Système de visualisation des cartes électroniques et d'information (SVCEI)
Depuis un certain temps, les sociétés commerciales se sont rendu compte de la valeur et de l'utilité des cartes électroniques qui peuvent être élaborées de façon relativement simple, à partir de cartes en papier. Par conséquent, le secteur privé offre maintenant de nombreuses «cartes électroniques». Cependant, comme ces données commerciales ne proviennent pas d'une organisation hydrographique autorisée par l'État, les cartes ne sont pas conformes aux normes de rendement de l'OMI ni à la norme de données S-57 de l'Organisation hydrographique internationale (OHI). Elles ne peuvent donc être utilisées pour remplacer les cartes en papier.

À l'avenir, la durée générale de transmission des données S-57 pourrait être accélérée grâce à des consortiums mixtes (comme celui qui a été créé au Canada). Dans l'intervalle, les seuls pays de l'APEC qui ont réalisé des progrès significatifs dans l'élaboration des données de CEN sont le Canada, le Japon, Singapour et les États-Unis; néanmoins, l'Australie et Hong Kong ont pris l'engagement de s'occuper bientôt de cette question.

La valeur du SVCEI réside dans sa capacité de combiner les cartes numérisées et les données de positionnement de navigation en temps réel qui sont fournies par le GPS/DGPS. Une mise à jour plus fréquente des cartes serait également un avantage important. Selon les renseignements obtenus, des pays comme le Canada et le Japon utilisent le SVCEI en conformité avec les normes de l'OHI et de l'OMI. L'Australie et les États-Unis ont effectué des essais du système, tandis que Hong Kong commence la mise sur pied du programme de soutien au SVCEI.

L'OHI est chargée de l'élaboration des normes relatives aux cartes électroniques, qui compléteraient les normes de rendement élaborées avec le concours de l'OMI et qui formeraient la base du système SVCEI. On a publié l'ébauche finale (la troisième) de la norme en octobre 1996. L'OHI, au moyen de son système de base de données CEN mondial (WEND), a prévu le développement de CEN dans la région, par l'intermédiaire des centres régionaux de coordination des cartes électroniques de navigation (CENR). À l'heure actuelle, le seul CENR existant est celui de l'Europe du Nord, situé en Norvège; des essais devraient avoir lieu à la fin de 1997. Le concept des CENR ne peut fonctionner que si ces derniers peuvent conclure, avec les diverses organisations hydrographiques de la région, des ententes bilatérales sur la disponibilité des données et la tarification. Le ministère japonais de l'hydrographie a accepté de mettre sur pied pour l'Asie de l'Est un CENR dont la formation fait l'objet de discussions avec les pays voisins.

SATCOM
Aujourd'hui, le principal système de communications maritimes par satellite est l'INMARSAT; en 1995, ce dernier assurait les communications maritimes d'environ 30 000 navires commerciaux ou gouvernementaux du monde entier (soit 25 p. 100 du total) et ce, à partir de quatre satellites dont l'emplacement permet de couvrir toutes les grandes régions océaniques et maritimes. Le nombre d'utilisateurs augmente rapidement et il devrait atteindre 90 000 dès 1997.

À l'heure actuelle, le Système mondial de détresse et de sécurité en mer (SMDSM) est la principale composante des systèmes de communications maritimes par satellite dont la mise en oeuvre se poursuit. En 1971, l'OMI a cerné les besoins et a commencé l'élaboration du SMDSM. Selon les consultations auprès de l'APEC, des centres de coordination des opérations de sauvetage (CCOS) ont été créés en Australie, au Canada, aux États-Unis, au Japon et à Hong Kong; on procède à la mise sur pied de tels centres à Singapour et en Thaïlande. Les Philippines emboîteront le pas au cours de la prochaine année. Il est particulièrement important pour les pays retardataires de mettre en oeuvre le SMDSM car, selon la Convention internationale pour la sauvegarde de la vie humaine en mer (SOLAS), ce système doit être opérationnel d'ici 1999. Par conséquent, au cours des deux prochaines années, un certain nombre de pays porteront leur attention sur le SMDSM.

Outre les systèmes radio à fréquence moyenne, élevée et très élevée, la plupart des pays (sur lesquels des données existent) disposent d'installations de communications par satellite. Ces services sont fournis par un ou plusieurs des nombreux systèmes INMARSAT destinés à la navigation maritime. À l'heure actuelle, les Philippines et la Thaïlande sont les seuls pays qui n'offrent pas de communications par satellite; toutefois, on y envisage l'incorporation de ces communications au programme SMDSM.

Sommaire des niveaux de mise en oeuvre

Au tableau 2, on retrouve les niveaux de mise en oeuvre de NCS qui ont été attribués à chaque économie. Les critères ci-dessous ont alors servi à fixer un niveau élevé, moyen ou faible à un pays (parfois on a attribué le niveau «moyen-élevé») :

- l'implantation des technologies NCS à ce jour;
- la participation aux travaux de développement et aux essais;
- le niveau de mise en oeuvre des technologies NCS à atteindre dans le pays;
- le calendrier d'implantation des technologies NCS.

QUESTIONS RELATIVES À LA MISE EN OEUVRE

Au fur et à mesure que la région Asie-Pacifique adopte les technologies fondées sur les satellites, on a soulevé de nombreuses préoccupations et questions qui pourraient modifier les étapes et l'importance des coûts et des avantages de la mise en oeuvre des technologies NCS. L'OACI et l'OMI coordonnent leurs efforts pour cerner et examiner ces questions. Toutefois, l'APEC peut également prendre des mesures qui aideront ces organisations internationales à résoudre les questions de mise en oeuvre et de transition.

Souveraineté et volonté politique
Cette question est cruciale pour le secteur aviation, mais moins importante dans le cas du secteur marine. La mise en oeuvre initiale du CNS/ATM a fait porter l'attention sur les questions de souveraineté, notamment : les risques touchant les recettes, les emplois et l'espace aérien ainsi que le «contrôle» du système. Il fallait également élaborer des formules sur le partage des installations qui assurent la protection des intérêts de tous les pays. Ces problèmes de souveraineté varient d'un pays à l'autre; il faut donc adopter une approche régionale pour les surmonter. On doit établir le nombre et l'emplacement optimums des installations, qu'il s'agisse de systèmes de satellites, de stations de référence et de stations principales, ou encore, de services de contrôle de la circulation aérienne (ATC) dans la région de l'APEC. Du point de vue de la navigation maritime, les questions de souveraineté peuvent également influer sur l'implantation des CENR.

Tableau 2 : Tableau récapitulatif des niveaux de mise en oeuvre des technologies NCS

Pays	Niveau de mise en oeuvre	
	Marine	Aviation
Australie	Moyen - élevé	Élevé
Brunei Darussalam	s.o.	Faible - moyen
Canada	Élevé	Élevé
Chili	s.o.	Moyen
République populaire de Chine	Moyen	Élevé
Chine de Taipei	Faible	Faible
Hong Kong	Moyen - élevé	Moyen - élevé
Indonésie	s.o.	Moyen
Japon	s.o.	Élevé
République de Corée	s.o.	Moyen - élevé
Malaisie	Moyen	s.o.
Mexique	s.o.	Moyen
Nouvelle-Zélande	Faible	Élevé
Papouasie-Nouvelle-Guinée	s.o.	s.o.
Philippines	Faible	Faible
Singapour	Moyen	Élevé
Thaïlande	Faible	Élevé
États-Unis	Élevé	Élevé

s.o. - Données non disponibles pour soutenir l'évaluation du niveau de mise en oeuvre

Sécurité nationale
Compte tenu de l'importance que prennent les services de navigation et de communications par satellite fournis par des tiers, qu'il s'agisse de sociétés privées ou publiques, certains pays craignent une érosion de leur autorité et de leur contrôle sur leur espace aérien.

Harmonisation des capacités et calendrier de mise en oeuvre
Afin de réaliser pleinement les avantages des technologies NCS, il est crucial que les pays de l'APEC harmonisent les capacités de leurs divers systèmes, leur calendrier de mise en oeuvre ainsi que l'application des normes et règlements, de façon à offrir un environnement d'exploitation sans interruption.

Dédoublement de l'équipement et des services
On encourage les différents pays à se consulter pour harmoniser la mise en oeuvre des systèmes NCS; il est également important de donner des conseils et une orientation pour les persuader de collaborer afin d'éviter les dédoublements des systèmes et des services offerts.

Coordination et planification
Les pays de l'APEC ne pourront réaliser tous les avantages des technologies NCS que s'ils communiquent avec les pays voisins et coordonnent leurs plans de mise en oeuvre. Ces derniers doivent être élaborés par toutes les économies de la région. Grâce à la compatibilité entre les systèmes et à l'évitement des dédoublements, on cherchera à harmoniser l'équipement et les services, les mesures de sécurité, les efficiences et les réductions de coût.

Disponibilité et application des normes et règlements
L'absence de normes et de spécifications pourrait avoir les résultats suivants : un retard dans la mise en oeuvre des technologies NCS, le recours à un équipement ou à des procédures non standard, ou encore, la nécessité de disposer d'équipement de divers types pour accomplir des tâches analogues de navigation et de communications dans les divers secteurs d'une région ou dans des régions différentes. Ces conditions pourraient avoir des répercussions sur la sécurité, les dédoublements et les coûts, en particulier si le matériel ne peut être mis au niveau de la norme approuvée.

Aide technique
De nombreuses économies ont un besoin crucial de soutien technique externe; elles préfèrent que ce soutien soit assuré par l'intermédiaire de l'OACI. Cette aide technique est nécessaire dans beaucoup de domaines, notamment : transmission des données, RTA, ADS, réorganisation de l'espace aérien, attestations, facteurs humains et analyse coûts-avantages. Dans certains cas, il faut non seulement un transfert de connaissances, mais également un apport de personnel au moment où de nombreux pays procèdent à la mise à niveau des systèmes terrestres actuels.

Coûts et financement nécessaire
La mise en oeuvre des technologies NCS rendra nécessaire des investissements importants dans un certain nombre de domaines, par exemple : le développement des systèmes, l'achat et l'installation de l'équipement, les coûts d'exploitation et d'entretien ainsi que les coûts connexes de transition, comme la formation, la réduction des effectifs, les retraits du service et l'élaboration des procédures. Dans le cas des utilisateurs et des économies, la disponibilité du financement est une question importante qui est étroitement liée aux coûts de la mise en oeuvre et de l'exploitation des technologies NCS.

Formation
Les pays ont accordé beaucoup d'importance à l'établissement des ressources humaines nécessaires ainsi que des besoins en gestion et en formation. Cette question est particulièrement importante au moment où des technologies NCS extrêmement complexes

sont installées dans les aéronefs, sur les ponts des navires ainsi que dans les stations de contrôle et de surveillance. Une aide sera nécessaire pour assurer l'exécution et le financement de ces activités.

Acceptation par les utilisateurs
Il est crucial que les utilisateurs du système de transport acceptent la technologie afin que soient réalisés les nombreux avantages de celle-ci. Ces avantages, qui ont justifié les investissements nécessaires, dépendent de la proportion des utilisateurs qui adopteront les technologies NCS. Les possibilités de ces dernières ne pourraient être réalisées que si un pourcentage minimum d'utilisateurs disposent de l'équipement adéquat. Il peut être utile que les principaux bénéficiaires encouragent certains utilisateurs marginaux à se doter de l'équipement nécessaire.

MESURES POSSIBLES DE L'APEC

Incitations en faveur du soutien
Le Groupe de travail chargé des transports de l'APEC rassemble ministres, politiciens et techniciens. Il est important que les organisations en cause reçoivent un soutien politique; sans ce dernier, l'engagement envers les technologies NCS sera limité. Cette tribune pourrait servir à souligner l'importance du soutien fourni aux divers pays ainsi que des travaux de planification et de mise en oeuvre dans la région de l'APEC.

Coordination et planification
La coordination et la planification de la mise en oeuvre des technologies NCS sont importantes; il serait donc utile de constituer une autre tribune régionale pour favoriser l'exécution de ces activités. On pourrait passer en revue les plans régionaux de mise en oeuvre, comme le plan APANPIRG, pour vérifier si les différentes économies affichent des progrès conformes aux prévisions.

Normes et règlements
L'APEC pourrait appuyer l'OACI et l'OMI dans leurs rôles de concepteurs de normes et de règlements. En particulier, l'APEC pourrait participer à l'application des normes de l'OACI, de l'OMI et de l'industrie dans l'ensemble de la région.

Aide technique, financement et formation
L'APEC pourrait favoriser des travaux de mise en oeuvre des technologies NCS dans les trois domaines suivants :

- aide technique - offrir une tribune pour la diffusion des données et des renseignements techniques;
- financement - fournir des moyens et des crédits ou favoriser la conclusion d'ententes de financement pour diverses activités, comme la planification, l'enseignement et la formation, la mise en oeuvre de WGS-84 et autres;
- formation - fournir une aide aux organisations internationales et régionales dans le cadre de programmes de formation.

Échange de renseignements
L'APEC pourrait offrir un mécanisme d'échange de nombreux types de données, y compris les données techniques, les plans de mise en oeuvre et les calendriers d'exécution pour la région Asie-Pacifique et pour d'autres pays ainsi que les programmes et installations de formation.

CONCLUSIONS

Conclusions relatives au secteur aviation

En fonction des renseignements obtenus, on a tiré les conclusions suivantes au sujet des plans d'action, des questions et des mesures possibles de l'APEC à l'égard des technologies NCS.

Plans de mise en oeuvre

- D'ici l'an 2005, toutes les économies membres (sur lesquelles nous disposions de renseignements) auront entamé ou achevé la mise en oeuvre du système CNS/ATM.

- D'ici l'an 2005, dans la plus grande partie de la région, des systèmes comme le MTSAT du Japon ou le WAAS des États-Unis permettront de renforcer les signaux sur une vaste étendue.

- D'ici l'an 2000, les services CPDLC et ADS seront offerts largement dans l'espace aérien océanique; les utilisateurs bénéficieront des importants avantages que procurent un itinéraire souple et des écarts réduits.

- Les pays membres n'ont pas tous établi leurs plans pour la transition au RTA et à l'ADS-RTA; il est important qu'ils maintiennent la coordination entre les fournisseurs de services et les utilisateurs pour assurer une transition efficace et efficiente qui serait avantageuse pour tous.

On a attribué les niveaux de mise en oeuvre suivants aux divers pays :
- **Élevé -** Australie, Canada, Chine, Japon, Nouvelle-Zélande, Singapour, Thaïlande et États-Unis;
- **Moyen -** Chili, Hong Kong (moyen-élevé), Indonésie, Mexique et la Corée du Sud;
- **Faible** - Brunei Darussalam, Chine de Taipei et les Philippines;
- Aucune évaluation - Malaisie et Papouasie-Nouvelle-Guinée.

- La région Asie-Pacifique a entamé l'étape de mise en oeuvre et d'exploitation de CNS/ATM.

Questions de mise en oeuvre des technologies NCS
- Cette question a suscité un niveau élevé de réponses qui seront vraisemblablement représentatives de l'opinion des pays membres.

- Les pays qui ont répondu au questionnaire étaient préoccupés surtout par les questions de mise en oeuvre suivantes :
  - harmonisation et non-interruption du service (6/13);
  - normes et règlements (5/13);
  - coûts et financement (5/13);
  - formation (5/13);
  - acceptation par les utilisateurs (5/13);
  - coordination et planification (4/13).

Mesures de l'APEC
- Le taux élevé de réponses à cette question laisse croire que les principales mesures de l'APEC mentionnées seront vraisemblablement représentatives de l'opinion des pays membres.

- Principales mesures possibles de l'APEC :
  - aide financière (en particulier dans le domaine de la formation) (8/10);
  - échange de renseignements (7/10);
  - coordination et planification (6/10);
  - encouragement et soutien (4/10).

- Les pays membres n'ont pas précisé si les mesures de l'APEC devaient avoir pour but d'apporter une solution à la question de l'existence de normes et de règlement.

Conclusions relatives au secteur marine

En fonction des renseignements recueillis, on a tiré les conclusions suivantes au sujet des plans de mise en oeuvre, des questions et des mesures possibles de l'APEC à l'égard des technologies NCS. Il importe de souligner que les conclusions ci-dessous sont fondées sur des données en provenance de dix pays seulement; par conséquent, elles peuvent donner une image incomplète des plans de mise en oeuvre des technologies NCS dans la région.

Plans de mise en oeuvre

- La mise en oeuvre du DGPS progresse: deux pays disposent de réseaux opérationnels et quatre autres ont entamé les travaux.

- On remarque une lente progression du SVCEI: quatre pays seulement utilisent actuellement cette technologie et un autre a mis sur pied un programme de soutien pour le SVCEI.

- La disponibilité des CEN S-57 de l'OMI dans la région pourrait être compliquée car seulement quatre pays ont réalisé des progrès notables dans l'élaboration des données CEN, même si deux autres ont pris un engagement à court terme en ce sens.

- À deux exceptions près, les onze pays sur lesquels nous disposons de renseignements touchant les capacités de communications offrent des services de communications par satellite.

- Un certain nombre des pays de l'APEC cherchent à mettre en oeuvre le SMDSM et non les technologies NCS, comme le DGPS et le Système automatisé d'identification (AIS).

- On a attribué aux différents pays les niveaux suivants de mise en oeuvre :
  - **Élevé** - Canada et États-Unis;
  - **Moyen** - Australie, République populaire de Chine, Hong Kong (moyen-élevé), Malaisie (moyen-élevé) et Singapour;
  - **Faible** - Chine de Taipei, Nouvelle-Zélande, Philippines et Thaïlande;
  - Aucune évaluation - Brunei Darussalam, Chili, Japon, Indonésie, Mexique, République de Corée et Papouasie-Nouvelle-Guinée.

- En général, la mise en oeuvre des technologies NCS dans le secteur marine progresse lentement dans la région Asie-Pacifique.

Questions de mise en oeuvre des technologies NCS

- Compte tenu du faible taux de réponses à cette question, les principaux sujets peuvent ne pas être représentatifs de l'ensemble de la région de l'APEC.

- Les pays membres ont cerné les principales mesures possibles de l'APEC :
  - coût et financement (4/5);
  - normes et règlements (3/5);
  - harmonisation et non-interruption du service (3/5).

Mesures de l'APEC

- Comme cette question a suscité peu de réactions, les principales mesures de l'APEC peuvent ne pas être représentatives de toute la région.

- Voici les principales mesures possibles de l'APEC, selon les économies membres :
  - coordination et planification (4/4);
  - aide financière (3/4);
  - normes et règlements (3/4);
  - aide technique (3/4).

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1. Introduction

1.1 Background

The Asia-Pacific Economic Cooperation (APEC) comprises 18 economies: Australia, Brunei Darussalam, Canada, Chile, the People's Republic of China, Chinese Taipei, Hong Kong, Indonesia, Japan, the Republic of Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, the Republic of the Philippines, Singapore, Thailand, and the United States of America. These economies have agreed to cooperate in four areas: global and regional economic development, global trade liberalization, and regional cooperation in specific sectors. One of the sectors identified is transportation. The Transportation Working Group (TPT/WG) was created to coordinate that effort.

The ambitious agenda for liberalizing trade in the region will bring about a rapid increase in air and marine traffic and a requirement for higher levels of aircraft and shipping throughput. This demand for increased capacity is driving the application of satellite communications, navigation and surveillance technologies and systems. It is apparent from discussions in the TPT/WG that the economies of APEC share an interest in introducing new technologies and systems in a way that maintains or improves transportation safety.

The Canadian Minister of Transport has made a commitment to APEC Ministers of Transportation to lead the promotion of transport system safety in the APEC region. To that end, Transport Canada proposed a study on the implementation of satellite navigation and communications (SN&C) for both of air and marine. The study is a component of the APEC Action Program in Transportation.

The study is composed of the following elements:

- Element 1 - Inventory of Existing and Planned Satellite Navigation and Communications Systems in the APEC Economies;

- Element 2 - Satellite Navigation and Communication Technology and Safety Review; and

- Element 3 - Costs and Benefits of Satellite Navigation and Communications for Air and Marine Transportation.

Hickling Corporation was contracted to carry out the work and detailed reports have been prepared and are available for each of the three elements. This report presents Part 2, Implementation Plans, of the final report for Element 1. A separate report presents the first part, Part 1: Trade and Traffic.

Part 2: Implementation Plans Report

This report presents the aviation and marine SN&C implementation plans for the APEC economies, Element 1 of the Study. In particular this report:

- Describes the data collection process used to obtain the necessary information and data to conduct the study;
- Introduces the findings on the economies' plans for the implementation of satellite-based air and marine navigation and communication systems;
- Assesses actual or anticipated implementation issues and the scope seen for concerted action by authorities in the APEC economies to overcome these problems; and
- Presents conclusions.

1.2 Structure of Report

Chapter 1 Introduction presents background information regarding the APEC SN&C Study and the five elements that were undertaken. Chapter 2 describes the data collection process for compiling the required information and the results that were obtained. A summary of the economies SN&C implementation plans are presented in Chapter 3. Chapter 4 describes the implementation issues that were identified by the economies while Chapter 5 presents the potential APEC actions that may assist in resolving those issues. Finally, Chapter 6 presents conclusions based on the findings of this element.

1.3 SN&C as Compared to CNS/ATM

As described above, the focus of the APEC SN&C Study is the implementation of satellite-based communication and navigation equipment or SN&C in the APEC region. There are a number of technologies which fall under this heading such as the Global Positioning System and satcom data link. The International Civil Aviation Organization has developed a global plan to transition to satellite-based communications, navigation **and** surveillance (CNS) including the required air traffic management capabilities (ATM). In aviation these satellite-based technologies have come to be referred to as the new CNS/ATM systems. In this report, the SN&C acronym has been used exclusive for the marine sector; for the aviation sector, the SN&C term is used where possible but in many instances the CNS/ATM term is more appropriate.

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2. Data Collection

2.1 Data Collection Process

The data collection was conducted primarily through the review of relevant documentation and consultations with experts and stakeholders from both the user and the provider groups. All data gathering was coordinated with the Transportation Development Centre (TDC) scientific authorities. Data was collected on the following five aspects of satellite navigation and communication for marine and air transportation in the APEC region:

- Trade and traffic patterns;
- Implementation plans and issues;
- SN&C technologies;
- Safety; and
- Economics.

A four-stage approach to data collection was developed:

- Documentation Review;
- Data Collection Instruments;
- Contact List; and
- Consultations.

2.1.1 Documentation Review

A thorough literature search was conducted to identify, compile and review documented information of SN&C technologies, systems, implementation plans and issues. Sources include the Internet, electronic library searches, TDC, other government departments, the International Civil Aviation Organization (ICAO), the International Air Transport Association (IATA), the International Maritime Organization (IMO) and other relevant organizations. The documentation review provided background and support for the consultation process. A detailed bibliography has been compiled which contains over one hundred items, each of which has been reviewed. The types of documents obtained include reports, plans, conference proceedings, articles and newsletters. Appendix A presents the bibliography.

2.1.2 Data Collection Instruments

This stage involved the design of a consultation guide and accompanying data collection forms. The guide was used to structure the consultation process. It included a description of the project and a series of questions and issues which are the focus of the interview. The interview guide was founded on the Analysis Framework for the project. The interview guide and questionnaire are contained in Appendix B. The Analysis Framework segments and integrates the data requirements of the five aspects of the study described above. The interview guide was tested with SN&C experts and approved by the scientific authorities.

2.1.3 Contact List

In consultation with our team experts, the TDC scientific authorities, and other knowledgeable sources, a list of contacts in the APEC economies, ICAO, IMO and other international agencies has been developed. Contact lists already available from ICAO, for example, were a useful starting point. A summary of the contact list is presented in Appendix C.

2.1.4 Consultations

Consultations were arranged and conducted with the economy representatives to the APEC TPT/WG and other international agencies such as ICAO, IMO and INMARSAT. Information was collected by telephone, fax, E-mail and personal interviews. Members of our study team were in the APEC region during the study period and conducted interviews with a variety of stakeholders. In view of the leading role played by the United States in providing SN&C technologies and systems, a visit to Washington to discuss future technical and operational planning with the Federal Aviation Administration (FAA), the U.S. Coast Guard and RTCA Inc. was also conducted.

Responses to the consultation guide and questionnaire were obtained either through an interview or via facsimile. Interviews were conducted using the guide as a framework and questionnaires were left behind to be completed and returned. A full record of the interview and any supplemental information obtained has been held by U.S. in confidence. A data file for each economy has been developed. The interviews were used to corroborate and expand upon the information acquired in the documentation review.

If a representative was contacted by fax, the interview guide and the questionnaire were sent with a covering letter from TDC attached describing the project's background. If a response was not obtained from Hickling's initial contact, an alternate contact if available (from the APEC Vancouver Meeting Delegates List) was tried. If an alternate was not available, the information was re-sent to the original person. A final set of telephone calls was made in an attempt to obtain information from the economies that had not responded to the second round contacts.

2.2 Data Collection Results

Contacts were made with the APEC TPT/WG members from all of the economies. Data was collected through interviews, responses to the consultation guide and documentation. Responses to the consultation guide and supplemental information have been varied. The initial round of contacts resulted in Marine authorities in eight out of the 18 economies responding and aviation authorities in nine economies responding. The second round of consultation resulted in four more economies for the aviation sector and two additional responses for marine. At the end of the data collection process, fifteen of the eighteen economies responded for their aviation sector by either filling out the questionnaire and/or sending documentation; while nine responded for marine. Data was then collected from other sources such as articles, home pages on the Internet and second-party documents to provide information for all but one economy in the aviation sector and four in the marine sector. Table 2-1 presents a summary of the data collected from each of the economies.

As can be seen from Table 2-1, complete data (i.e., detailed implementation plans, responses to consultation guide, supporting documentation) for the aviation sector were collected from eleven of the eighteen economies, for the marine sector from eight economies. Basic data (i.e., less detailed implementation plans, no or sketchy response to consultation guide, minimal documentation) has been collected for aviation from four economies; and marine, three economies. Finally, minimal data (i.e., no implementation plan, no or limited response to consultation guide, little or outdated supporting documentation) has been collected from two economies for aviation and two for marine. Economy reports (see Chapter 3) were prepared from the available documentation and submitted to each economy for their review and comment.

Table 2-1: Summary of Data Collection Results by Economy

Economy	Sources of Marine Information			Sources of Aviation Information			Data Completeness		Economy Report Comments Received	
	Interview	Guide	Docmn't	Interview	Guide	Docmn't	Marine	Aviation	Marine	Aviation
Australia	✔		✔	✔		✔	●	●	✔	✔
Brunei	No data was available				✔		None	▲		
Canada	✔		✔			✔	●	●	✔	✔
Chile	No data was available				✔		None	▲		✔
China			✔			✔	■	■		
Chinese Taipei		✔			✔		●	●		
Hong Kong			✔		✔	✔	▲	●		
Indonesia	No data was available					✔	None	■		
Japan			✔			✔	▲	▲	✔	✔
Korea	No data was available				✔		None	●		✔
Malaysia		✔			✔		●	●		
Mexico			✔		✔	✔	■	●		✔
New Zealand	✔		✔	✔	✔	✔	▲	●		
PNG	No data was available									
Philippines	✔		✔		✔		●	●	✔	✔
Singapore	✔				✔	✔	●	●	✔	✔
Thailand	✔				✔	✔	●	▲	✔	✔
United States	✔		✔	✔		✔	●	●		

● **Completed Data** ▲ **Basic Data** ■ **Minimal Data**

Data collection efforts also resulted in a number of personal interviews. In-person interviews were completed directly with six economies for a total of 48 people interviewed (see Appendix D for the names of individuals) as follows:

- Australia - 14 individuals;
- Canada - 4 individuals;
- New Zealand - 7 individuals;
- Philippines - 8 individuals;
- Thailand - 9 individuals; and
- United States - 8 individuals.

While in attendance at the Vancouver APEC Transportation Working Group, economy delegates were also approached to obtain information and data to supplement the analysis. Interviews were also conducted with individuals of the following international organizations:

- IMO
    - Capt. Fossum, Director of Safety

- ICAO
    - Vladimir D. Zupkov, Chief Regional Affairs Office;
    - Normand Ostiguy, Regional Affairs Officer;
    - Hassan Tehrani, Regional Affairs Officer; and
    - Douglas Mein, Air Navigation Commissioner, Permanent Mission of Canada.

- INMARSAT
    - Jim Fehr

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3. Implementation Plans

3.1 Introduction

This chapter presents both the aviation and marine SN&C implementation plans for the APEC economies. The emphasis of the review was placed on identifying the existing and planned applications, size of the user base, issues and successes to date. The analysis begins with a general overview of the transition to these technologies. Next a summary of the economies' plans is presented, including an assessment of the level of implementation that has been achieved to date by each economy, traffic and highlights of success to date. Finally, a general summary of SN&C implementation for the Asia-Pacific Region is given.

Integral to this analysis was the preparation of Economy Reports which are presented in Appendix E. For each economy a report was prepared using a wide range of information that had been collected over the course of the study. An Economy Report presents general information on the economy such as geography, transportation infrastructure and trade. For both the aviation and marine sector, information under headings such as general description, traffic, SN&C implementation plans and level of SN&C implementation is presented. The format of an Economy Report is described below:

- **General Description** - a description of the economy's geography, population and transportation infrastructure.

- **Trade** - General trade data including export and import trading partners and commodities for the economy.

- **Aviation SN&C Implementation** - presents information under the following sub-headings:

    - *General Description* - a description of the service provider and facilities (i.e., airspace structure, number of Area Control Centres, towers, etc);

    - *Traffic* - historical and/or forecasts of passenger and aircraft traffic;

- *Present and Future Infrastructure* - a summary of the present and proposed technologies, both conventional and SN&C, which the economy uses for their air navigation system;

- *Highlights of Current SN&C Work* - a description of the work that the economy has done in the areas of SN&C implementation plans, operational trials, technologies implemented, involvement in regional groups, etc.;

- *SN&C Implementation Plans* - presents the SN&C technologies to be implemented and the scheduled date for initial operations in the economy;

- *Level of SN&C Implementation* - based on the economy's current SN&C work and the future plans for SN&C, a level (high, medium, low) is assigned to identify a level of implementation;

- *Issues Identified* - presents specific issues regarding the transition to SN&C technologies as identified by the economy; and

- *Potential Actions Identified* - presents the potential role/actions that APEC could undertake to reduce or eliminate transition issues, as specified by the economy.

- **Marine SN&C Implementation** - presents marine SN&C implementation information under the same sub-headings as were used for aviation.

- **Data Sources** - presents the data sources that were used to prepare the economy report.

3.2 Aviation Implementation Plans

3.2.1 Overview of CNS/ATM

Before presenting the specific implementation plans for the SN&C technologies, an overview of the CNS/ATM concept is provided. The main features of the global concept for the CNS/ATM systems can be summarized as follows:

- Communication

    - Data and voice communication will be by direct satellite/aircraft links for the larger part of the region. Initially, High Frequency (HF) voice may have to be maintained in the transition period and over polar regions until such time as satellite communication is available or HF data link is proven operationally feasible.

- Very High Frequency (VHF) will remain in use for voice and data communication in many continental and terminal areas.
- The Secondary Surveillance Radar (SSR) Mode S data link may be used for air traffic services purposes in high density airspace.
- The Aeronautical Telecommunication Network (ATN) will provide the interchange of digital packet data between end-users over dissimilar air-ground and ground-ground communication links.

- Navigation
    - Progressive introduction of Area Navigation (RNAV) capability in compliance with the Required Navigation Performance (RNP) criteria.
    - Global Navigation Satellite System(s) (GNSS) will provide worldwide coverage and will be used for aircraft navigation and for non-precision-type approaches (at least near Category I approaches).
    - Instrument Land System (ILS), Microwave Landing System (MLS) and GNSS will be used for approach and landing in accordance with the ICAO strategy.
    - Non-directional Radio Beacon (NDB) and VHF Omnidirectional Radio Range/Distance Measuring Equipment (VOR/DME) will be progressively withdrawn.
- Surveillance
    - SSR Mode A/C or S will be used in terminal areas and high-density continental airspace.
    - Automatic Dependent Surveillance (ADS) will be used over oceanic/continental airspaces primarily where radar coverage is unavailable.
    - The use of primary radar will diminish.

3.2.2 Summary of Economies' Plans

Summary of Economies' Aviation Plans

It is important to note that the following information on implementation plans is based on information that was collected from the economies and other sources of information between March and October of 1996. Given the rapid implementation of CNS/ATM in the region, this information may become outdated quickly. Also, implementation dates are based on the economies having initial operational capabilities and these may be available only on certain routes or in limited portions of an economy's airspace.

Nowhere in the world is the transition to CNS/ATM being accomplished more rapidly than the Asia-Pacific region. Not only have most of the economies developed their implementation plans for the transition to CNS/ATM, but many of them already have some elements of the CNS/ATM system operational. The following information describes the region's accomplishments and their future plans for implementing the key components of CNS/ATM.

Planning Efforts

Many economies have developed implementation plans for the transition to CNS/ATM. These economies include, but are not necessarily limited to, Australia, Canada, New Zealand, Thailand and the United States. A concerted effort is being made by many of the other economies to prepare their implementation plans. A detailed regional plan, Asia/Pacific Regional Plan for the New CNS/ATM Systems (1/3/96), has also been developed through the efforts of ICAO's working group, Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG).

Controller Pilot Data Link Capability (CPDLC)

The controller pilot data link capability (CPDLC) provides direct satellite/aircraft links allowing data and voice communications between the pilot and the controller. CPDLC is an integral component of CNS/ATM implementation. It is a requirement for ADS and eventually will eliminate the need for HF communications. The economies are well on the way to having CPDLC available in the region. Australia, New Zealand, Singapore and the United States have satellite data link communications (based on the ARINC 622 communications - see ADS discussion). China will initial operations of CPDLC in 1996 with Japan, Korea, Malaysia, and Thailand following suit in 1997.

ADS Implementation

Satellite navigation, communication and surveillance systems are not only being planned in the region but also implemented. In the South Pacific, current implementation of CNS/ATM systems is focussing on ADS. Today, ADS is operational in New Zealand's, Australia's, Singapore's and the United Sates' oceanic airspaces; in the next two years it will become operational in China, Hong Kong, Japan and Thailand.

A noteworthy result has been reduced separations and the implementation of flexible tracks in the South Pacific. These routes are primarily being used by Quantas, Air New Zealand, United Airlines, Singapore Airlines and Cathay Pacific Boeing 747-400 using the FANS-1 equipment.

It is important to note that the ADS data link is accomplished via INMARSAT II Pacific Ocean Region (POR) Satellite and current implementation is based on the ARINC 622 specification (known as FANS-1) and does not meet the requirements of the ATN. In order to obtain the major benefits associated with flexible routing and reduced separations as early as possible, it was decided to implement a system based on the ARINC 622 standard instead of waiting for the ATN Standards and Recommended Procedures (SARPS) which are currently under development. As a result economies that have implemented early (i.e., Australia, New Zealand, Singapore, etc.) will have an ADS system based on FANS-1 architecture while economies that wait for the ATN SARPS (i.e., Canada) will have a different architecture.

In order to have a global seamless system, it will be necessary for economies and users that have implemented the ADS FANS-1 system to transition to an ATN-based system at a later date. Economies such as Australia and New Zealand have identified the date for this transition while other economies have not. It will be important in the region to take careful consideration of the implementation of ADS by both the economies and the users to ensure that operations across the region are as seamless and efficient as possible and at the same time minimize implementation costs.

GNSS

Progress has also been made on the implementation of GNSS. Currently, the Global Positioning System (GPS) has been approved for en route use in Australia, Canada, New Zealand and United States; approval is scheduled for Singapore in 1997. Significant work has also begun on the development of GPS overlays for non-precision approaches in Australia, Canada, Singapore and the United States.

The region is evaluating the potential for a Regional Augmentation System (RAS). Japan is currently developing its Multi-Functional Transport Satellite (MTSAT) which will be the backbone of the air-ground data/voice communication system. This system will provide a means for ADS and GNSS augmentation in the region. The current schedule indicates that the system will have initial operational capability in 1999. The United States also has begun development of their augmentation system known as the Wide Area Augmentation System (WAAS). WAAS will provide coverage over the continental United States, portions of Canada and the Pacific Ocean as far west as Hawaii. The system will have initial operational capability in 2000.

Australia is actively investigating the implementation of a wide area augmentation system. The economy has awarded a contract to undertake a GNSS augmentation systems audit and cost benefit analysis for Australian civil aviation. Australia has also joined forces with New Zealand and the United States to develop an Augmentation Systems Test Bed (ASTB) in Australia during 1996-97. The aim of the ASTB is "to improve the integrity of GPS and GLONASS systems to support sole-means en route, non-precision approach and, where the appropriate, differential corrections are provided, Category 1 precision approach requirements."

ATN

The ATN will provide for the interchange of digital data between a wide variety of end system applications supporting end users. Implementation of the ATN will allow for a seamless and global interchange of aeronautical information worldwide. It is an integral component of CNS/ATM and each economy needs to plan for its implementation. Only Australia, Canada, Chile, New Zealand, Singapore and the United States have set specific dates for the transition to the ATN. New applications are being defined so that the transition from the Airlines Electronic Engineering Committee (AEEC) 622, Aircraft Communications Addressing and Reporting System (ACARS) standard to the ATN data exchange will require minimum redesign of existing applications. However, it is important that all economies include a transition timescale to the ATN in their implementation plans.

3.2.3 Levels of SN&C Implementation

The following presents the levels of SN&C implementation that were assigned to each of the economies. The assignment of a high, medium or low level to an economy (in some instances a level such as medium to high was assigned) was based on the following criteria:

- Implementation of the CNS/ATM technologies to date;
- Involvement in development work and operational trials;
- Degree to which CNS/ATM is to be implemented in the economy; and
- Schedule for implementation of the CNS/ATM technologies.

High

The following economies were assessed to have high levels of implementation.

Australia is considered to have a high level of implementation. With the implementation of CPDLC, Australia will reduce separations and implement flexible routing and is conducting ADS trials in the Oceanic Sectors. This economy is committed to the development and implementation of satellite-based navigation. It has approved the supplemental use of GPS, is moving forward on the development and implementation of stand-alone GPS non-precision approaches, and is implementing the ASTB. Based on implementation plans, Australia currently has initial operations of all elements of the SN&C technologies except for wide area augmentation of GNSS; but assessment of this technology is well under way.

Canada is considered to have a high level of implementation. They have developed a comprehensive CNS/ATM transition and implementation plan that describes both the present and future air navigation systems (ANS) and presents priorities, objectives and activities for implementing SN&C technologies. The economy is vigorously pursuing implementation and approval for GNSS and the Wide Area Augmentation System (WAAS) as the sole means of navigation in both its domestic and oceanic airspace. Canada has conducted critical trials and demonstrations of ADS and CPDLC in the North Atlantic. Implementation of ADS/CPDLC (using ATN standards) is scheduled for 1999. Based on the current implementation plans, Canada will have initial operations of the primary elements of the SN&C technologies by 2000.

China has a high level of SN&C implementation. Economic analysis of SN&C technologies has been conducted. Planning for the transition to these technologies is progressing and significant operational trials are being undertaken on various aspects of SN&C technologies. Based on the current implementation plans, China will have initial operations of the primary elements of the SN&C technologies by 1998.

Japan was assessed to have a high level of SN&C implementation. Trials and demonstrations on the various components of SN&C have been underway for over three years. The economy is developing its MTSAT technology which will provide satellite data link capabilities and wide area augmentation to the Asia-Pacific region. The economy has plans to implement a full CNS/ATM system by the year 2001, with capabilities such as ADS and data link available in 1997.

New Zealand is considered to have a high level of implementation. They have developed a comprehensive and detailed air navigation plan that maps the transition to an SN&C based system. They currently have an oceanic control system (based on FANS-1) operational with plans to move to a full ATN based ADS by 2000. New Zealand is also moving quickly to adopt GNSS and its augmentation. GNSS has been approved for en route and non-precision approaches use. The New Zealand Airways Corporation also plans to implement augmentation and if feasible adopt GNSS for Cat II/III approaches. Based on implementation plans, New Zealand currently has initial operations of the primary elements of the SN&C technologies except for wide area augmentation of GNSS; but the economy plans to connect to a regional system such as WAAS or MTSAT.

Singapore has a high level of SN&C implementation. The economy is committed to the development and implementation of a satellite-based air navigation system. Satellite communications, both voice and data, and ADS have been operational in the economy's airspace since 1995. The Civil Aviation Authority of Singapore plans to implement a full CNS/ATM system which will be operational by 1999.

Thailand has a high level of SN&C implementation. The economy has developed detailed implementation plans and has conducted a cost-benefit analysis of CNS/ATM implementation. Trials and demonstrations have been underway for a number of years with a variety of SN&C components. In 1997, the economy will have operational use of AMSS and VHF data link, and ADS.

The United States is considered to have a high level of implementation. The economy has developed a detailed plan for the transition to a full CNS/ATM system and eventually "free flight". The United States is conducting operational trials of ADS with plans for full operations in the near future. GNSS has been approved for en route, terminal and non-precision approaches. WAAS is under development and is scheduled for implementation in 2000. The United States plans to implement a full CNS/ATM system and will have initial operations of the primary SN&C technologies by 2000.

Medium

The following economies were assessed to have a medium level of implementation.

Chile has a medium level of SN&C implementation. Planning for the transition to these technologies is well underway and transition has begun with the availability of satellite communications. Chile will have implemented a full SN&C system by the year 2010.

Hong Kong has a medium to high level of implementation of SN&C technologies. Planning for transition is well underway in the economy. Operational trails of ADS are just beginning in economy and the CAA is currently investigating GNSS and its applications. Based on the current implementation plans, Hong Kong will have initial operations of all elements of the SN&C technologies by 1998.

Indonesia was assessed to have a medium level of SN&C implementation (given the limited information available). No SN&C technologies have been implemented to date but Indonesia has begun investigation into a regional satellite system. Indonesia is planning to implement a full CNS/ATM system but operational dates for the components were not available.

The Republic of Korea has a medium to high level of SN&C implementation. The economy has progressed far in a short time having only begun focussing efforts on SN&C implementation in 1992. Operational trails are underway however no components have been implemented to date. The economy does plan to implement a full CNS/ATM system which will be operational by the year 2000.

Mexico has a medium to high level of SN&C implementation. The economy is developing a detailed implementation plan and plans to implement a full CNS/ATM system with many components operational in 2000. However, Mexico has not yet implemented CNS/ATM systems as of 1996.

Low

The following economies were assessed to have a low level of implementation.

Brunei is considered to have a low to medium level of implementation. Given their airspace requirements, the economy needs to implement a basic system. While they have begun planning for transition to SN&C , Brunei has not yet implemented any components. Based on current implementation plans, Brunei will have initial operations of the SN&C technologies by 2003.

Chinese Taipei has a low level of SN&C implementation. Initial investigations into RNAV and GPS have just begun. The economy has not outlined any implementation plans nor begun operational trials.

The *Philippines* was assessed a low level of implementation given the available information. There are currently no plans for SN&C implementation. The economy is upgrading its ground-based system.

Summary

In summary, eight of the economies were assigned a high level of implementation. This was to be expected given the rapidity that the Asia-Pacific region is transitioning to CNS/ATM. Five economies were assigned a medium level and three were assigned a low level of implementation. Due to a lack of data, it was not possible to assess the level of four economies. The following levels of implementation were assigned to the economies:

- High
  - Australia;
  - Canada;
  - China;
  - Japan;
  - New Zealand;
  - Singapore;
  - Thailand; and
  - United States.
- Medium
  - Chile;
  - Hong Kong (Medium-High);
  - Indonesia;
  - Korea; and
  - Mexico.
- Low
  - Brunei;
  - Chinese Taipei; and
  - Philippines.
- No assessment
  - Malaysia; and
  - Papua New Guinea.

Table 3-1 summarizes for each economy the information that was discussed above as well as some passenger traffic data.

Table 3-1: Summary of Economies' Plans for Aviation SN&C Implementation

Economy	Int'l Passenger Traffic (millions)			Indicate CNS/ATM Technologies to be Implemented													Level of SN&C Imple-mentation
				Satcom Voice	Satcom Data Link	HF Data Link	Mode S Data Link	VHF Data Link	ATN	GNSS/RNAV					ADS		
	1993	2000	2010							En Route	TMA	NPA	Wide Area	Local Area	FANS-1	ATN	
Australia	11.2	20.3	43.2	●	● (cyan)	○		●	● (yellow)	● (cyan)	● (cyan)	● (cyan)	● (red)	?	● (cyan)	●	High
Brunei	na	na	na				●	●		●	●	●					Low Med
Canada	21.9	30.6	51.0	●	● (red)	○	○	○	● (red)	● (cyan)	● (cyan)	● (cyan)	●	●		● (red)	High
Chile	na	na	na	●	●	●		●	●	●	●	●	●	●		●	Medium
China	8.3	24.7	62.3		● (green)				?	● (yellow)	● (yellow)	● (yellow)	?	?	● (green)	?	High
Chinese Taipei	13.5	28.5	56.8							○	○	○					Low
Hong Kong	24.4	41.1	72.3		● (yellow)				?	● (yellow)	● (yellow)	● (yellow)	● (red)	?	● (yellow)	?	Med High
Indonesia	6.0	11.4	26.1	No Data Available													Medium
Japan	34.9	53.0	90.9		● (yellow)				?	● (yellow)	● (yellow)	● (yellow)	● (red)		● (yellow)	?	High
Korea	11.3	20.4	42.8		● (yellow)				?	● (yellow)	● (yellow)	● (yellow)	?	?		● (red)	Med High
Malaysia	8.0	12.9	24.6		● (yellow)				?							● (red)	na
Mexico	4.7	5.7	na	○	● (red)	○	○	●	●	● (green)	● (yellow)	● (yellow)	●	○	● (red)	●	Medium
New Zealand	4.2	6.1	10.1	●	● (cyan)			●	● (yellow)	● (cyan)	● (cyan)	● (cyan)	● (yellow)	●	● (cyan)	●	High
PNG	na	na	na	No Data Available													
Philippines	5.7	10.3	22.0	Currently have no plans for SN&C Implementation													Low
Singapore	18.7	31.4	59.5		● (cyan)			● (yellow)	● (red)	● (yellow)	● (yellow)	● (yellow)		● (yellow)	● (cyan)	?	High
Thailand	13.3	24.6	54.5		● (yellow)			● (yellow)	●	● (yellow)	● (yellow)	● (yellow)	● (yellow)	● (yellow)	● (green)	?	High
United States	419.0	524.0	na	●	● (cyan)	○	○	○	● (red)	● (cyan)	● (cyan)	● (cyan)	●	● (yellow)	● (green)	● (red)	High

● (cyan) Currently Operational ● (green) 1996 ● (yellow) 1997 ● (yellow) 1998 ● (red) 1999 ● 2000+ ○ Under Investigation ? No Date Available

3.2.4 Summary of Regional Plans

It is important to note that the successful implementation of the FANS-1 technology is due in a large part to the work of the Informal South Pacific ATS Coordinating Group (ISPACG). This group involves six member and two observer states, three principle airlines, two communication service providers and several airframe and vendor manufacturers. By bringing a complete group of stakeholders to the development of the technology, remarkable achievements were made in two years:

- Aeroplane equipment was designed, manufactured and certified.
- Ground equipment was designed, manufactured and certified.
- Operational procedures were developed and ratified.
- Necessary communication protocols were developed.

The success of this informal group indicates that this approach to implementation has a great deal of merit. Consideration should be given to use of such groups in the future; and perhaps APEC could play a role in the development and support of informal working groups that bring industry together with other stakeholders such as airlines and economies.

The APANPIRG Asia-Pacific Regional Plan has set out an ambitious schedule for the future implementation of CNS/ATM. The APANPIRG CNS/ATM Sub-group identified the time scale for transition to the new CNS/ATM systems which shows that a significant number of the new systems would be in operation in the region in the period 1995 - 2000. A broad indication of timescale of actions resulting from the transition plan is as follows:

- 1990 - 1997 Developments, trials, pre-operational demonstrations.
- 1993 - 2000 Gradual implementation and use of various elements of the system. Some aircraft and administrations will use the CNS/ATM systems with backup from the terrestrial systems.
- 2000 - 2005 Full CNS/ATM services available in parallel with existing systems so that appropriately equipped aircraft could have operating credits solely on CNS/ATM systems.

- 2005 - 2010 The terrestrial system, not required for CNS/ATM, progressively dismantled.

- 2010 CNS/ATM is the sole system.

In particular, the region will see the implementation of CNS/ATM systems as follows:

- By 2005 all economies (for which information is available) have either initiated implementation or achieved operational use of the CNS/ATM systems.

- All economies will have implemented data link via VHF, HF, AMSS and/or Mode S by 2000.

- WAAS is expected to be available by 2000 with Pacific coverage forecasted to reach Hawaii.

- Japan's MTSAT implementation will have begun providing a regional augmentation system by 1999 with completion scheduled for 2005.

- ADS will be available throughout most of the oceanic airspace in the region by 2000.

- End-state is achieved by 2010.

It is also necessary to consider the impacts of CNS/ATM implementation on the current terrestrial system. As was noted in the regional plan, systems not required for CNS/ATM are expected to be withdrawn in the region over the period of 2005 to 2010. The withdrawal of these systems is one of the benefits of CNS/ATM to the aviation authorities. It is important to dismantle these systems as soon as it is safe and practical to do so because the costs of operating two systems can be expensive.

Plans for the region's terrestrial system are as follows:

- 2000 Omega will cease operation;

- 2005 Most marine beacons will be decommissioned; and

- 2010 Following aviation navaids are expected to be decommissioned – VOR/DME, NDB, TACAN, Loran-C, ILS Category I, Primary Radar.

It is expected that the transition to CNS/ATM will have a limited impact on current comm systems as VHF is an adequate and inexpensive communication system

3.3 Marine Implementation Plans

3.3.1 Summary of Economies Plans

There are four primary SN&C technologies that have applications in the marine environment. They are as follows:

- GPS/GLONASS;
- Differential GPS (DGPS);
- Electronic Navigation Chart (ENC)/Electronic Chart Information Display System (ECDIS); and
- SATCOM.

GPS/GLONASS

Unlike aviation, there is less criticality to the signal availability, reliability and integrity of GPS/GLONASS (operational as of Jan. 18/96) for marine navigation. As a result, marine users have been able to incorporate the use of GPS for navigation without the immediate need of augmentation systems. This technology is available across the Asia-Pacific region and is used primarily by large commercial ships and other classes of vessels in ocean/offshore areas, where navigational hazards are not a significant factor, and accuracies of basic GPS/GLONASS are acceptable. It is also increasingly being used by smaller vessels, including recreational vessels, particularly in coastal and inland waterways, due to falling prices for receivers.

DGPS

In the marine mode, DGPS is largely used by large commercial ships in confined waterways, including ports, harbours, and harbour approaches. Other users include specialized marine activities involving exploration and hydrographic services. Publicly provided DGPS is currently available in many areas of the Unites States, notably the coastal areas and in major inland waterways. In Canada, publicly-provided DGPS was made available in the summer of 1996 in coastal areas and in the Great Lakes/St. Lawrence waterway. Other economies indicating implementation of DGPS through reference stations include:

- Australia, with two reference stations currently in place, and an additional reference station being considered for the Great Barrier Reef and Torres Strait area. (Note: Austrailia and PNG have tabled a joint proposal with the IMO to implement a Mandatory Ship Reporting System in this area.)

- A complete system of RB/DGPS will be implemented to provide navigation and plotting in Chinese ports and coastal waters. It is expected that the system will provide the high precision navigation service for Chinese and foreign users in these areas as of 1997.

- Hong Kong and Singapore have established DGPS reference stations that provide coverage in the port area.

ENC/ECDIS

For some time now, commercial firms have realized the value and desirability of electronic charts that could be developed fairly simply from paper charts. As a result, there is a proliferation of "electronic charts" supplied by the private sector. However, the fact that commercially-developed data does not originate from a government-authorized Hydrographic Organization (HO) means that the charts do not comply with IMO Performance Standards or the International Hydrographic Organization data standards (S-57), and cannot be used as a substitute for paper charts.

Private-public consortiums (e.g., such as that established in Canada) may lead to a faster overall delivery of S-57 data in the future. In the meantime, Canada, Japan, Singapore, and the United States are the only APEC economies to have progressed significantly in the development of ENC data, although Australia and Hong Kong are committed to the near-term development.

The real value of ECDIS is in the ability to combine digitized charts with real-time navigational positioning such as that offered by GPS/DGPS. Major benefits may also be realized in the more frequent update of chart data. With respect to update of the ECDIS data in the future, satellite communication (e.g., INMARSAT) is perceived as a highly effective approach for the update and dissemination of data, including update of data between providers/distributors of chart data and users. Economies such as Canada and Japan put ECDIS to practical use meeting IMO and IHO standards. Australia and the United States have been conducting operational trials of the system while Hong Kong is beginning their program to support ECDIS.

At the 19th IMO Assembly in November 1995, Performance Standards for ECDIS were adopted. The next steps toward implementation of ECDIS include member states' adoption of national regulations related to ECDIS.

The IHO is responsible for the development of electronic chart standards that would complement the performance standards developed in cooperation with IMO and form the basis for the ECDIS system. A final (third) draft edition of the standard was announced in October 1996. The IHO, through its Worldwide ENC Database (WEND) system has planned for ENC to be developed on a regional basis through Regional ENC Coordinating Centres (RENCs). At present, the Northern European RENC, based in Norway, is the only one to be established and is planning operational trials in late 1997.

For the concept of RENCs to work, it is necessary for the RENCs to establish bilateral agreements with the individual HOs within the region, covering conditions for availability of data, and reimbursement for use. The Japanese Hydrographic Department has agreed to set up a RENC for East Asia and is discussing the formation with neighbouring countries.

SATCOM

The principle marine satellite communication system in use today is INMARSAT which as of 1995 provided marine communications to approximately 30 000 (or 25 percent) commercial or government ships around the world from four satellites placed to cover all the major oceans and seas. The number is growing dramatically and is expected to reach approximately 90 000 as soon as 1997.

Currently, the General Maritime Distress and Safety System (GMDSS) is a major element to the continuing implementation of satellite-based marine communications systems. In 1971, the IMO identified requirements and began development of the system that is referred to as GMDSS. The most vital functional requirement of GMDSS is the distress alert, which is sent by an Emergency Position Indicating Radio Beacon (EPIRB), via satellite, to a shore Rescue Coordination Centre (RCC), as well as to other ships in the vicinity.

GMDSS also encompasses communication of essential safety information related to ships at sea. Two dedicated systems are used. The first system is NAVTEX, a terrestrial MF service with a broadcast range of up to 450 miles. It is currently mandatory for all ships over 300 GRT. The second system, which is voluntary, makes use of INMARSAT, and is a satellite-based communication/broadcast system which will cover all non-polar waters. Information from APEC consultations indicate that RCCs have been established in Australia, Canada, the United States, Japan, Hong Kong and are being implemented in Singapore and Thailand. The Philippines will begin implementation within the next year. The implementation of GMDSS is a primary importance to economies that have not yet done so as the Safety of Life At Sea (SOLAS) convention requires implementation by 1999. As a result, GMDSS will be the focus of a number of economies over the next two years.

In addition to the medium, high and very high frequency radio systems, the majority of economies (for which data was available) have satellite communication capabilities. These services are provided by one or more of the many INMARSAT systems available for maritime use. Only the Philippines and Thailand do not currently have satellite communications but both economies are planning for these communications as part of their GMDSS programs.

Domestic Mobile Satellite Services

In addition to INMARSAT, a number of other economies have developed MSS services. For example, MSAT, which is almost in place to serve North America, will provide Mobile Satellite Services to light, portable equipment at relatively low cost. It will serve the marine market that operates in inland waters and those vessels which operate within the 200 mile economic zone. In the future, worldwide coverage (including the oceans) is expected from global satellite systems such as Globalstar and Iridium. Australia also has an MSS (Optus) that covers wide coastal waters as far north as New Guinea.

3.3.2 Levels of SN&C Implementation

The following presents the levels of SN&C implementation that were assigned to each of the economies. The assignment of a high, medium or low level (in some instances a level such as medium to high was assigned) was based on the following criteria:

- Implementation of DGPS and ECDIS technologies and development of ENC to date;
- Involvement in development work and operational trials;
- Degree to which the SN&C technologies are to be implemented in the economy; and
- Schedule for implementation of the SN&C technologies.

High

The following economies were assessed to have high levels of implementation.

Canada has a high level of SN&C implementation. The economy has implemented an extensive DGPS system and to support these stations will establish five manned control and monitoring stations. Canada is also actively investigating the implementation of an Automatic Identification System (AIS). The economy has conducted significant trials on the use of DGPS/ECDIS involving 47 different ships on both east and west coasts, the Great Lakes and the St Lawrence River. The Canadian Hydrographic Service (CHS) has digitized a significant number of charts to international standards.

The United States was assessed to have a high level of implementation. The economy is providing DGPS service at harbours and in the Great Lakes (in cooperation with Canada) and will have its system fully operational by the end of 1996. The economy has been involved in trials of ECDIS and is actively digitizing its charts to international standards. Vessel traffic services are currently provided at eight ports with the potential for implementation at another 23 sites. Several initiatives are underway to improve and upgrade equipment at Vessel Traffic Service (VTS) sites including AIS.

Medium

The following economies were assessed to have medium levels of implementation.

Australia has a medium to high level of implementation. The economy has implemented three DGPS broadcasting stations and developed plans for the implementation of further DGPS broadcasting stations. They have begun development of an ENC database and are supporting the use of Electronic Chart Systems (ECS). Australia is also investigating the implementation of ECDIS.

China was assessed to have a medium level of implementation based on the available information which was limited to a paper on their DGPS work. A complete system of RB/DGPS will be implemented to provide high precision navigation and plotting in Chinese ports and coastal waters. It is expected that the system will provide formally the high precision navigation service for Chinese and foreign users in these areas as of 1997.

Hong Kong has a medium to high level of implementation of SN&C technologies based on the information available. The economy has implemented a DGPS reference station and has begun converting their charts to digital format. However, no information was available on future plans for DGPS or AIS.

Malaysia has a medium level of SN&C implementation. The establishment of DGPS is underway in this economy and will be completed in 1998. Malaysia also has plans to supplement its current infrastructure with VHF data link and NAVTEX. However, it is unclear what work is being undertaken in the areas of electronic navigation charts for Malaysian waters and ECDIS.

Low

The following economies were assessed to have low levels of implementation.

Chinese Taipei was assessed as having a low level of SN&C implementation. Current work is focussed on providing vessel traffic services at two major harbours. The economy has no plans for the implementation of DGPS at this time.

New Zealand was assessed to have a low level of SN&C implementation. New Zealand has no requirements for DGPS, as the service is not viewed as cost -beneficial. No other plans were identified for implementation of AIS or ECDIS.

The *Philippines* has a low level of SN&C implementation based on available information. The economy is currently planning to implement search and rescue technologies but not until 1999. There are currently no plans for implementing DGPS and no operational trials have been conducted.

Singapore is assessed to have a medium level of SN&C implementation in the marine sector. The MPA's efforts are being directed to implementation of GMDSS and COPAS-SARSAT, and to compliance with international standards in navigation and surveillance, no plans for the implementation of SN&C in the near future have been developed.

Thailand has a low level of SN&C implementation. Current work is focussed on upgrading communications and implementing GMDSS. The economy has not begun any work in the areas of DGPS or ECDIS and has no plans for their implementation in the near future.

Summary

In summary, only two of the economies were assigned a high level of implementation. The focus for many of the economies in the region is the implementation of GMDSS which is required under SOLAS. Four economies were assigned a medium level and five were assigned a low level of implementation. A lack of data made it impossible to assess the level of seven economies. The following levels of implementation were assigned to the economies:

- High
  - Canada; and
  - United States.
- Medium
  - Australia (Medium-High);
  - China;

  - Hong Kong (Medium-High);
  - Malaysia; and
  - Singapore.

- Low
  - Chinese Taipei;
  - New Zealand;
  - Philippines; and
  - Thailand.
- No assessment
  - Brunei;
  - Chile;
  - Japan;
  - Indonesia;
  - Mexico;
  - Korea; and
  - Papua New Guinea.

Table 3-2 summarizes for each economy the information that was discussed above as well as some cargo and vessel traffic data.

Table 3-2: Summary of Economies' Plans for Marine SN&C Implementation

Economy	Selected Port Statistics for 1993				SN&C Technologies								Level of SN&C Imple-mentation
	Selected Port	TEUs ('000)	Shipping Tonnage ('000)	Vessel Arrivals	**Satellite Comm.**	**VHF Data Link**	**ENC**	**ECDIS**	**GPS**	**DGPS**	**AIS**	**GMDSS**	
Australia	Melbourne	na	36 239	2 610	🟢		🟡	🟡	🟢	🟡		🟢	Medium
Brunei	No data was available												
Canada	Vancouver	434	60 800		🟢	🟡	🟡	🟡	🟢	🟢	🟡	🟢	High
Chile	No data was available												
China	No data was available								🟢	🟡	No data avail.		Medium
Chinese Taipei	Kaohsiung	4 636	211 428	12 888	**Currently have no plans for SN&C implementation**								Low
Hong Kong	Hong Kong	9 204	148 903	33 042	🟢		🟡	🟡	🟢	🟡		🟢	Med High
Indonesia	No data was available												
Japan	Kobe	2 696	296 806 [1]	83 551 [1]	🟢	No data was available						🟢	na
Korea	Pusan	3 071	135 329 [1]	23 714 [1]	No data was available								
Malaysia	na	na	na	na	**Currently have no plans for SN&C implementation**								Medium
Mexico	No data was available												
New Zealand	Wellington	na	na	3 032	🟢	Currently have no plans for implementation							Low
PNG	No data was available												
Philippines	Manila	1 247	28 984	3 283	🔴							🔴	Low
Singapore	Singapore	9 046	623 800	92 655	🟢					🟡		🟡	Medium
Thailand	Bangkok	na	16 869	2 409								🟡	Low
United States	Long Beach	2 310	na	na	🟢	🟡	🟡	🟡	🟢	🟡	🟡	🟢	High

🟢 Operational 🟡 Under Development/Implementation 🔴 Planned

[1] Data for 1992

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4. Issues

4.1 Introduction

As the Asia-Pacific region progresses toward satellite-based technologies, many concerns and issues regarding implementation have arisen. Concerted efforts are being undertaken by ICAO and IMO to identify and address these issues. However, there may also be actions which APEC can take that will assist these international organizations in resolving these implementation and transition issues.

4.2 Description of Issues

4.2.1 Sovereignty and Political Will

This is a critical issue for aviation but a lesser one for marine. The initial implementation of CNS/ATM has focussed attention on sovereignty issues. These include:

- The potential threat to revenues, jobs, and airspace and system "control".

- The need to find formulae for the sharing of facilities that safeguard the basic concerns of all economies.

These sovereignty concerns differ according to economy and a regionally based approach to overcome them is required. There is a need to establish the optimum number and location of facilities whether for satellite systems, reference and master stations or Air Traffic Control (ATC) services for the APEC region. From a marine perspective, the duplication of RENCs may also be affected by sovereignty concerns.

An example of the sovereignty issue arose at the second meeting of the APANPIRG CNS/ATM Implementation Coordination Sub-group meeting in Bangkok in the fall of 1995. During this meeting, one of the economies announced that it is in the process of declaring its airspace sovereign. There is a great deal of consternation in the South Pacific that other island states might follow, resulting in a highly fragmented airspace infrastructure in the region if the move is approved. This would negate many of the positive impacts of satellite-based systems, which require no boundaries. Also, some economies fear that changes to Flight Information Region boundaries are inevitable and that these could adversely affect an economy's authority and revenue potential from users.

Individual economies are ultimately responsible for SN&C implementation. This requires high level political will providing "top-down" direction to the technical/operational level. Both economies and users must not only share the will to implement but must also cooperate to unlock the "Catch 22" situation where realisable benefits encourage investment in equipment and systems. Ground-based systems must be developed in unison with the user-systems (e.g., avionics and ECDIS). Only by all working together will the desired progress be achieved.

4.2.2 National Security

With the move towards services such as navigation and satellite communications being provided by third parties, be they private or public, some economies fear that the level of authority and control over their airspace may be diminished.

4.2.3 Harmonization of Capabilities and Implementation Timing

In order to achieve the full impact of the aviation CNS/ATM technologies, it is critical that the APEC economies harmonize the capabilities of their systems to allow a seamless operating environment. One of the primary objectives of CNS/ATM implementation is to provide a global and seamless system. If economies decide not to use these technologies, to use technologies that are incompatible with other economies' CNS/ATM systems or to delay their implementation, this objective will not be met and accrual of benefits will be reduced or delayed. As a result, all economies are unanimous in the need for greater liaison between economies and their neighbours, and better coordination of CNS/ATM implementation plans.

Harmonization of implementation plans and timing is also an issue concerning the marine environment, particularly as it relates to the development and distribution of the ENCs. Hydrographic authorities throughout the world are scrambling to provide the digital hydrographic infrastructure necessary to support the use of electronic chart technology. Moreover, it is critical that the authorities responsible for the development of digital data for the ENCs closely follow specifications and standards or the data may not be properly exchanged, delaying or possibly even preventing the development of the Worldwide Electronic Navigational Chart Database (WEND).

The development of WEND also depends on a network of Regional Electronic Navigational Chart Coordinating Centres (RENC) that would integrate the chart data collected by national

Hydrographic Offices (HO). The WEND model is designed to inhibit duplication of chart compilation and digital data delivery. Each coastal economy is responsible for the data in its own Economic Zone. Data sets provided by HOs will not overlap each other apart from ensuring good edge matching (to be provided by the RENC). However, this means that each economy must provide their data for complete coverage of the region. The benefits of electronic chart technologies such as ECDIS may be limited if ENC data is incomplete or the data is incompatible. Therefore, coordination of ENC development is an important issue, as full implementation will depend on cooperation between states within designated regions.

Coordination between economies may also be required for marine with regard to the implementation of DGPS. Various bodies of water with high traffic levels, such as the Strait of Malacca and Torres Strait, may benefit from the implementation of DGPS. Coordination between the economies affected to provide the necessary DGPS coverage (with each station accommodating an area up to 100 kilometres in diameter) would likely benefit all involved. Again, the benefits potential will not be achieved unless sufficient geographic coverage is attained, especially for critical (i.e., confined) and congested areas.

While it is important for economies to consult and coordinate, it is also crucial to involve the stakeholders, in particular, the early adopters. Users such as airlines and ship operators, as well as SN&C service and equipment providers should all be involved in the implementation process where such coordination would prove to be useful and beneficial.

4.2.4 Duplication of Equipment and Services

Whilst encouraging economies to consult with each other in harmonizing implementation of SN&C systems, it is also important, through advice and guidance, to persuade economies to collaborate in the provision of systems and services to avoid duplication. The potential for the proliferation of equipment and services is a growing concern in the region, as this will create unnecessary cost that could affect the APEC economies' ability to fund the investment or to recover the investment from system users. One-way economies, especially smaller ones, may benefit from SN&C technologies is to purchase the required services from other economies (or from third party service providers).

A particular concern for the aviation sector is the potential proliferation of ground earth stations (GES) for satellite communications. Most of the APEC economies have indicated that, for national security reasons, they would prefer to own and operate their own GES. For example, an economy's CNS/ATM implementation plan may include consideration of a GES for its territory - a decision which may be based as much on national aspirations as on technical requirements.

INMARSAT has estimated that for a GES to break even, it needs to be handling approximately ten percent of the global aviation traffic. Since there are already over ten GESs in operation worldwide, not all are currently able to recover their costs. Additional concerns surround the requirement for each GES to continuously provide users with system status and configuration information. The satellite power necessary to send this signal is very expensive, estimated at $1 to $1.5 million dollars per year for each GES. Not only does the proliferation of GESs increase costs, which would be passed on to end users (who may not be willing to pay these), but each new GES also consumes the limited frequency spectrum allocated exclusively for aeronautical use.

The potential for duplication in the marine environment is not as great as for aviation, as satellite communications have been and will continue to be provided by the private sector. Given the line-of-sight restrictions for marine DGPS (since the correction signal is normally communicated via radio beacon LF), the potential for duplication of navigation services is limited. However, the number of RENCs required for the WEND could increase beyond the optimal number. Too many RENCs could negate some of the advantages, and only a few RENCs covering large geographic areas may be necessary. Clearly there will have to be some accommodations between sovereign ambitions and the economics of the market.

4.2.5 Coordination and Planning

In order to achieve the full benefits of the SN&C technologies, it is important that economies liaise with their neighbours and coordinate their implementation plans. Implementation plans need to be developed by all of the economies in the region to achieve harmonization of equipment and services, safety, efficiencies and cost-savings through compatibility between systems and avoidance of duplication.

4.2.6 Availability and Application of Standards/Regulations

Technology is no longer the issue -- standards are. The navigation and communications technologies are being introduced into the industry at a pace that regulators and standards bodies are having difficulty maintaining. As a result, economies are concerned that the development of standards and/or specifications, such as the specification for the ATN, or the performance testing standards for marine GPS receivers and ECDIS, is lagging with respect to the SN&C implementation plans. The unavailability of standards/specifications may result in the delay of SN&C implementation or the use of equipment or procedures with standards not agreed upon by international organizations such as ICAO and IMO. This may have possible safety and duplication implications, especially if the equipment is not upgradable to the approved standard.

Operations should be seamless to the system users in both the marine and aviation sectors. If SN&C technologies are developed to a variety of specifications, users may be forced to carry multiple types of equipment to accomplish similar navigation and communication tasks in different areas of the region or in different regions. There is also a growing concern that the provision of SN&C technologies such as DGPS and ENCs by the private sector may not meet the standards developed by bodies such as ICAO, IMO and IHO. It is important that the various stakeholders collaborate on the development and application of desired standards.

Another concern within this issue regards the development of Electronic Chart Systems (ECSs). ECSs have no performance standard and may well be using data of uncertain quality. However, once a ship has an ECS onboard, the navigator may tend to ignore the paper charts and navigate solely on the basis of the ECS. Given the potential inaccuracy of the data, this may not be a safe practice. However, it may prove difficult to reach a consensus on ECS specifications as some argue that only ECDIS should be allowed as a substitute for paper chart systems.

Another concern affecting both the aviation and marine sectors is the implementation of the WGS-84 standard. Many economies and users are unaware that, for example, different GPS manufacturers have employed different geodic reference models. Using different models within an area can result in aircraft and ships reporting erroneous positions relative to each other and the hazards, with differences of up to hundreds of metres. Economies need to be advised of its importance and may require assistance in implementation. Finally, issues may arise from the fact that GLONASS is not based on the WGS-84 standard but the PZ-90 standard. This results in GLONASS horizontal position estimates for a location surveyed in WGS-84 that are 10 m off-centre reflecting differences between the geometric coordinate frames of WGS-84 and PZ-90.

4.2.7 Technical Assistance

Many economies have expressed an essential need for external technical support, and their preference for such support to be provided through ICAO. Technical assistance is required in a wide variety of areas including but not limited to: data link communications, ATN, ADS, airspace reorganization, certification, human factors and benefit-cost analysis. In some instances not only a transfer of knowledge may be desired, but personnel may be needed as many economies are occupied with upgrading their terrestrial systems.

4.2.8 Costs/Funding Requirements

The implementation of SN&C technology will require significant investments in a number of areas including system development, procurement and installation of equipment, operations and maintenance, and related transition costs such as training, work force adjustment, decommissioning and procedures development. Availability of funding is an issue for both the users and the economies, and is closely related to the costs of the implementation of SN&C and its ongoing operations.

In the aviation sector, some economies believe that the transition and implementation of the SN&C systems will be expensive and will adversely affect their level of cost recovery. This understanding is often based on the economies' intention to establish a total nationally dedicated system along the lines of existing air traffic control systems. Furthermore, they may not understand that the SN&C systems may, in fact, result in lowering costs. Therefore, the level of cost recovery should not decline in the long run if the users adopt and are willing to pay for the new systems. Implementation of SN&C may also lead to substantial societal benefits in the form of increased economic activity, improved productivity, increased environmental protection, and so on. Indeed, a good understanding of the total costs and benefits to both the economies and users of satellite-based systems is essential in making informed decisions on how to proceed with the investment.

Economies may not understand how to utilize third party providers of communications and navigation services such as mobile satellite services, data link, and DGPS. Information about the potential role these organizations may have in assisting the economy in the provision of SN&C services may increase their use and potentially reduce the investments required by the economy if it were to provide these services.

4.2.9 Training

Economies have placed great emphasis on the importance of the identification of human resource requirements, management and training needs. This is especially the case with the introduction of the extremely complex SN&C technologies in avionics, ship bridges and control/monitoring stations. Demand may exceed the capacity of existing training organizations, which may result in untrained operators using the systems, or the use of training programs that do not meet minimum performance standards. Assistance will be required for both the provision and financing of these activities. These training logistics affect both the marine and aviation sectors.

4.2.10 User Acceptance

Many of the benefits of implementation will be governed by the acceptance of the technology by the transportation system users. Most users operate under commercial principles, in which investments require a positive return within an acceptable period (i.e., the benefits of an investment must exceed their costs). In the case of CNS/ATM, the benefits to aviation users that have made the necessary investments are dependent on the proportion of users that have yet to adopt the technology. As a result, the full potential may not be achievable until a certain threshold proportion of users are appropriately equipped. It may be worthwhile for the main beneficiaries to encourage some of the marginal users to equip. Alternatively, it may be necessary to divide the system into areas designated for equipped users only and general usage areas, and restrict from the designated area those that are not capable of using the satellite-based technologies and procedures.

4.3 Summary of Issues as Identified by the Economies

4.3.1 Aviation SN&C Implementation Issues

Of the eighteen economies, a response to the question regarding implementation issues was obtained from fourteen of them. These responses are summarized in Table 4-1 for each of the economies. Three economies did not identify any issues on their responses to the questionnaire. From the remaining eleven economies, the following results were obtained:

- Harmonization/Seamlessness - six out of eleven identified this as an issue;
- Standards/Regulations - five out of eleven;
- Cost/Funding - five out of eleven;
- Training - five out of eleven;
- User Acceptance - five out of eleven;
- Coordination/Planning - four out of eleven;
- Technical - two out of eleven; and
- Sovereignty, National Security and Duplication - one out of eleven, for each issue.

Table 4-1: Summary of Aviation SN&C Implementation Issues Identified by the Economies

Economy	Sovereignty	National Security	Harmonization/ Seamlessness	Duplication	Coordination / Planning	Standards/ Regulations	Technical	Cost/ Funding	Training	User Acceptance
Australia			●	●						
Brunei	●	●				●		●	●	●
Canada			●			●			●	●
Chile								●	●	●
China	No data was available									
Chinese Taipei			●		●		●			
Hong Kong								●		●
Indonesia	No data was available									
Japan	No issues were identified									
Korea	No issues were identified									
Malaysia	No data was available									
Mexico	No issues were identified									
New Zealand						●		●		●
PNG	No data was available									
Philippines					●					
Singapore			●		●	●	●			
Thailand			●		●	●			●	
United States			●					●	●	

The requirement for harmonization of capabilities and implementation plans in order to achieve a seamless and effective system was identified the most often as a key transition issue. Specific statements made by the economies on this issue include:

- A seamless system is required not only within the Asia-Pacific region but also between regions. In particular, approaches to and flights over India have been a principal choke point. Also of importance is the Russian Far East region.

- Challenge of implementing SN&C in a coordinated, seamless and timely manner.

- Incompatibility of implementation schedules among various regions.

Directly linked to the harmonization issue is the need for coordination and planning which was also highly ranked (4/11). Without regional planning efforts that include close collaboration and coordination, a harmonized and seamless system can not be implemented effectively. Specific statements made by the economies on this issue include:

- Continued support is required towards the implementation of the APANPIRG Plan within the economies.

- Coordination among economies and organizations is an issue. In particular, plans need to be coordinated in the adjacent FIRs in the region and requirements for support of the different groups need to be identified.

The availability of standards and regulations continues to be a concern to some of the economies in the region. The ability of organizations to develop standards and regulations have not kept pace with the development of, and some cases implementation of, the technologies. Specific statements made by the economies on this issue include:

- Timely development of operational and technical requirements and associated standards are required to ensure that different standards do not result in a plethora of equipment, both avionics and the ground infrastructure.

- Long delay of ICAO Standards and Recommended Practices.

The need for funding and training assistance continues to be a critical transition issue for the economies in the Asia-Pacific region. Assistance with funding is required in all areas of implementation including training. Training assistance is required in two areas: technical training such as seminars and workshops on the new CNS/ATM systems; and training for the personnel who will be operating and maintaining the new equipment. Specific statements made by the economies on this issue include:

- The cost of implementing SN&C technologies may be an issue; however, its impact should diminish as system costs will gradually reduce on acceptance of new technology in place of conventional navigation aids.

- Funding/venue assistance is required to support APANPIRG in its education opportunities and information exchange on CNS/ATM developments.

- The requirement of appropriate training programs and tools for both operations and maintenance of the SN&C systems.

- There are requirements for training that need to be met.

The final issue which a number of economies identified is user acceptance. The rate of user acceptance has had a direct impact on the implementation of the CNS/ATM systems. Users have been a key driver and in particular played a critical role in the implementation of ADS in the South Pacific. However, there will always be the "stragglers" who can have negative impact on the benefits achieved by those who have equipped. Specific statements made by the economies on this issue include:

- User equipage and the resulting ATM requirements to deal with mixed capabilities within the same airspace.

- Level of user acceptance and the time required for airlines and general aviation to adopt to new technology. Emphasis on equipment and procedures familiarity is required.

In summary, the CNS/ATM implementation issues that were identified the most by the economies who responded to the questionnaire were: Harmonization and Seamlessness, Standards and Regulations, Cost and Funding, Training, User Acceptance, and Coordination and Planning.

4.3.2 Marine SN&C Implementation Issues

Of the eighteen economies, a response to the question regarding implementation issues was obtained from ten of them. These responses are summarized in Table 4-2 for each of the economies. Five economies did not identify any issues on their responses to the questionnaire. In one instance, no issues were identified as the economy did not complete the questionnaire but sent documentation. In other instances, responses were left blank. Therefore, it is difficult to determine whether these economies felt that there are no issues regarding SN&C implementation or that they have not yet identified any.

This leaves five economies who did identify potential implementation issues. Given the small sample remaining it is difficult to make any generalizations regarding the issues faced by the implementers of SN&C technologies in the marine sector. However, the results are presented below.

From the remaining five economies, the following results were obtained:

- Cost/Funding - four out of five identified this as an issue;
- Standards/Regulations - three out of five;
- Harmonization/Seamlessness - three out of five;
- National Security - two out of five;
- Coordination/Planning - two out of five;
- Training - two out of five;
- User Acceptance - two out of five; and
- Technical and ENC Development - one out of five, for each issue.

The availability of funding to implement the SN&C technologies is a key issue to the economies. With substantial funds being spent on the development of ports, it is possible that less money is available for such systems as DGPS or ENC development. Specific statements made by the economies on this issue include:

- Costs of implementation and the need for sharing them among economies.

- The costs and associated funding requirements for implementation of technologies.

- The cost of the systems to both providers and users.

The development, availability and application of standards and regulations was an area identified often as an issue by the economies. In the marine environment, the development of regulations that are acceptable to users and can be enforced is often a difficult task especially as it regards new technologies. Specific statements made by the economies on this issue include:

- Different laws and regulations among the economies.

- Regulations are not keeping up with technology.

The last issue, harmonization and seamlessness, was also identified a number of times by the economies. Harmonization in this instance applies not only to systems and implementation plans but also to regulations and their enforcement. Vessels that do not meet regulations have posed a problem to safety and may continue to do so if this issue is not resolved. Specific statements made by the economies on this issue include:

- Different laws and regulations among the economies.

- Development and implementation of regulations is a potential action that is required.

- Implementation of VTS technologies (e.g., AIS) that are not interoperable.

In summary, the SN&C implementation marine issues that were identified the most by the economies who responded to the questionnaire were: Cost and Funding, Standards and Regulations, Harmonization and Seamlessness.

Table 4-2: Summary of Marine SN&C Implementation Issues Identified by the Economies

Economy	Sovereignty	National Security	Harmonization / Seamlessness	Coordination / Planning	Standards/ Regulations	Technical	ENC Development	Cost/ Funding	Training	User Acceptance
Australia	●	●						●		●
Brunei Darrusalam	No data was available									
Canada			●	●	●		●		●	
Chile	No data was available									
China	No data was available									
Chinese Taipei	**No issues were identified**									
Hong Kong	No data was available									
Indonesia	No data was available									
Japan	**No issues were identified**									
Korea	No data was available									
Malaysia	**No issues were identified**									
Mexico	No data was available									
New Zealand	**No issues were identified**									
Papua New Guinea	No data was available									
Philippines								●		●
Singapore	●	●	●		●	●		●		
Thailand			●	●	●			●	●	
United States	**No issues were identified**									

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5. APEC Actions

5.1 Introduction

As the Asia-Pacific region progresses toward satellite-based technologies, many concerns and issues regarding implementation have arisen. The specific issues that have been identified by the economies of the region were presented in the previous chapter.

It is very important to note that concerted efforts are being undertaken by ICAO and the IMO to identify and address these issues. However, there may also be actions which APEC can take that will assist these international organizations in resolving implementation and transition issues.

5.2 Description of Potential APEC Actions

The following sections describe, in general terms, the types of actions that APEC could possibly undertake. It is not intended to set out specific activities or action plans but to provide a general overview of the areas in which APEC could focus its efforts. It is assumed that APEC would maintain close collaboration with international organizations to ensure that any actions were of assistance to those organizations and did not duplicate but rather supported their work.

5.2.1 Encourage Support

The APEC TPT/WG brings together ministerial, political and technical individuals in a single forum. It is important that the political support be given to the organizations involved, for without political support, there will be limited commitment to SN&C. This forum could be used to stress the importance of providing support to individual economies as well as planning and implementation initiatives in the region.

5.2.2 Coordination/Planning

Given the importance of coordination and planning to the implementation of SN&C technologies, another regional forum that could be used to assist with these activities may be beneficial. Regional implementation plans such as the APANPIRG plan could be reviewed to ensure that the economies are progressing as per the schedule.

5.2.3 Standards/Regulations

APEC could possibly support ICAO and IMO in their roles as developers of standards and/or regulations. In particular, APEC could provide support for the implementation of ICAO, IMO and industry standards throughout the region.

5.2.4 Technical, Funding and Training Assistance

There are three primary areas were APEC may be able to provide assistance to the SN&C implementation efforts:

- Technical - provide a forum for the dissemination of technical data and information.

- Funding - provide venues, funding and/or assist with funding arrangements for a variety of activities such as planning, education and training, WGS-84 implementation, etc.

- Training - provide assistance to international and regional organizations with training programs.

5.2.5 Information Exchange

APEC could provide a venue for the exchange of many kinds of data including technical data, implementation plans and schedules for both Asia-Pacific as well as other economies, and training programs and facilities.

5.3 Summary of Actions as Identified by the Economies

5.3.1 APEC Actions Identified by the Aviation Sector of the Economies

Of the eighteen economies, a response to the question regarding implementation issues was obtained from fourteen of them. These responses are summarized in Table 5-1 for each of the economies. Four economies did not identify any issues on their responses to the questionnaire. For the remaining ten economies, the results are presented below.

Table 5-1: Summary of Potential APEC Actions as Identified by the Economies - Aviation Sector

Economy	Encourage Support	Coordination / Planning	Standards/ Regulations	Assistance			Information Exchange	Other
				Technical	Funding	Training		
Australia	●	●	●		●	●	●	
Brunei Darrusalam								●
Canada	●	●	●		●	●		●
Chile		●		●	●		●	
China	No data was available							
Chinese Taipei		●		●			●	
Hong Kong		●		●	●		●	
Indonesia	No data was available							
Japan	No actions were identified							
Korea	No actions were identified							
Malaysia	No data was available							
Mexico	No actions were identified							
New Zealand	●	●			●			●
Papua New Guinea	No data was available							
Philippines	No actions were identified							
Singapore				●	●		●	●
Thailand				●	●		●	
United States	●				●	●	●	

The potential action most often identified by the economies was the provision of funding assistance. Eight out of ten economies stated that APEC could play a role in this area. Specific statements made by the economies regarding this action include:

- Ensure resources are available to the planning and implementation efforts; such as WGS-84 surveys to accommodate satellite-based navigation.

- Assist with promoting, planning, establishment and funding of training programs.

- Assistance with funding and sharing of costs among economies.

Most economies, seven out of ten, indicated that providing a venue for the exchange of information was an important service that APEC could provide. Specific statements made by the economies regarding this action include:

- In consultation with ICAO, provide assistance to meet identified training and information exchange requirements for the implementation of CNS/ATM in the region.

- Facilitating training and information exchange. (It is expected that APEC will play a supporting role to ICAO in this area.)

- Dissemination of ICAO CNS/ATM concepts.

Given the number of economies that identified harmonization/seamlessness and coordination/planning as key implementation issues, it is not surprising that six out of ten respondents felt that APEC actions could provide coordination and planning support. Specific statements made by the economies regarding this action include:

- Play a main role in the coordination of implementation in the region.

- Assistance with coordination of implementation plans.

- Support regional cooperation in implementation activities. Monitor the progress towards implementation. For example, in three to five years the Congestion Point Study could be revisited.

Five of the ten economies indicated that ICAO could provide technical assistance. This assistance was typically related to the dissemination of technical data. Statements such as "Dissemination and provision of technical data" were typical of this action.

Another important role that APEC could play in the implementation of SN&C technologies is one of support and encouragement for the activities of regional organizations and individual economies. Specific statements made by the economies regarding this action include:

- Reinforce member economies support for their CNS/ATM committees, thereby promoting the use of CNS/ATM in the APEC region.

- Obtain an endorsement from the Transport Ministers for the ICAO APANPIRG Plan and in general, reinforce member economies' support for their CNS/ATM committees thereby promoting the use of CNS/ATM in the APEC region.

- Assist/intervene at the political level to encourage regional adoptions of SN&C technology and support their implementation committees.

Finally, economies sometimes identified actions that APEC could undertake which did not fit under the other categories. Some of these actions are presented below:

- Promoting common applications for aviation and marine uses such as the use of common equipment for satellite navigation purposes.

- Encourage private sector involvement in implementation programs and to ensure that service providers in their economies are structured in a way which gives greater control of projects and can deliver benefits to their respective customers and users.

In summary, the key potential APEC actions that were identified by the member economies were: funding assistance (8/10), information exchange (7/10), coordination and planning (6/10), and encouragement and support (4/10). It is interesting to note that while economies felt that the availability of standards and regulations have been an implementation issue, only two economies felt that APEC could play a role in this area.

5.3.2 APEC Actions Identified by the Marine Sector of the Economies

Of the eighteen economies, a response to the question regarding implementation issues was obtained from ten of them. These responses are summarized in Table 5-2 for each of the economies. As was the case with the identification of marine issues a number economies- six, did not identify any actions on their responses to the questionnaire. This leaves only four economies who identified potential APEC actions. Given the small sample remaining it is difficult to make any generalizations regarding the potential actions that APEC could undertake. However, the results are presented below.

All four economies felt that the coordination and planning of SN&C implementation was an activity that APEC could undertake. Specific statements made by the economies regarding this action include:

- APEC could play a prominent role with coordination and planning in the region. In particular, coordination is required in the area of availability, accessibility, commonalities and currency of databases.

- Encourage and support cooperation and coordination among national regulations and standards setting bodies.

Four out of four economies also indicated that APEC may be able support implementation by providing funding assistance. Specific statements made by the economies regarding this action include:

- Assist with the provision of financial assistance where required.

- APEC could encourage cooperation and assist with the provision of funding and technical assistance including training.

Three economies identified technical assistance as an activity in which APEC could be involved. As with the aviation sector, this assistance was typically related to the dissemination of technical data. Three economies also indicated that APEC may have a role in the area of standards and regulations. Specific statements made by the economies regarding this action include:

- Development and implementation of regulations.

Table 5-2: Summary of Potential APEC Actions Identified by the Economies - Marine Sector

Economy	Encourage Support	Coordination / Planning	Standards/ Regulations	Assistance			Information Exchange	Other
				Technical	Funding	Training		
Australia	●	●		●	●		●	●
Brunei Darrusalam	No data was available							
Canada	●	●	●	●	●		●	
Chile	No data was available							
China	No data was available							
Chinese Taipei	**No actions were identified**							
Hong Kong	No data was available							
Indonesia	No data was available							
Japan	**No actions were identified**							
Korea	**No actions were identified**							
Malaysia	No data was available							
Mexico	No data was available							
New Zealand	**No actions were identified**							
Papua New Guinea	No data was available							
Philippines	**No actions were identified**							
Singapore		●	●					
Thailand		●	●	●	●	●		
United States	**No actions were identified**							

- Encourage and support cooperation and coordination among national regulations and standards setting bodies.

Finally, economies sometimes identified actions that APEC could undertake which did not fit under the other categories. One of these actions is presented below:

- Examine options for the institutional and funding arrangements for a proposed future internationally-controlled GNSS for civil applications. (This examination would concentrate on the APEC region, but would have regard to European and worldwide developments proceeding in other fora.)

In summary, the key potential APEC actions that were identified by the member economies were: coordination and planning (4/4), funding assistance (3/4), standards and regulations (3/4) and technical assistance (3/4).

6. Conclusions

6.1 Aviation Conclusions

Based on the information presented in the previous chapters, the following conclusions have been made regarding SN&C technologies in the areas of implementation plans, implementation issues and potential APEC actions.

6.1.1 Implementation Plans

- By the year 2005, all member economies (for which information was available) will have either initiated implementation of or achieved operational use of the CNS/ATM system that they will be implementing.

- By the year 2005, wide area augmentation will be available throughout most of the region via systems such as Japan's MTSAT and/or the United States' WAAS.

- By the year 2000, CPDLC and ADS will be available throughout most of the oceanic airspace, providing users with the significant benefits associated with flexible routing and reduced separations.

- Member economies have not all identified their plans for transition ATN as well as ADS-ATN; it is important that economies do so to ensure that coordination between the economies and the users is maintained resulting in an effective, efficient and beneficial transition for economies and users, alike.

- The following levels of implementation were assigned to the economies:
  - **High** - Australia, Canada, China, Japan, New Zealand, Singapore, Thailand and the United States;
  - **Medium** - Chile, Hong Kong (Medium-High) Indonesia, Mexico and the Republic of Korea;
  - **Low** - Brunei Darussalam, Chinese Taipei and the Republic of the Philippines; and
  - No assessment - Malaysia and Papua New Guinea.

- The Asia-Pacific region has moved into the implementation and operational phase of CNS/ATM.

6.1.2 SN&C Implementation Issues

- Given the high level of response to this question, the identified key issues will likely be representative of the opinions of the member economies.

- The implementation issues that were of key concern to the economies who responded to the questionnaire were:
    - Harmonization and Seamlessness (6/13);
    - Standards and Regulations (5/13);
    - Cost and Funding (5/13);
    - Training (5/13);
    - User Acceptance (5/13); and
    - Coordination and Planning (4/13).

6.1.3 APEC Actions

- Given the high level of response to this question, the identified key APEC actions will likely be representative of the opinions of the member economies.

- The key potential APEC actions that were identified by the member economies were:
    - Funding Assistance (particularly in the area of training), (8/10);
    - Information Exchange (7/10);
    - Coordination and Planning (6/10); and
    - Encouragement and Support (4/10).

- Member economies did not indicate that APEC actions should focus on resolving the issue of availability of standards and regulations.

6.2 Marine Conclusions

Based on the information presented in the previous chapters, the following conclusions have been made regarding SN&C technologies in the areas of implementation plans, implementation issues and potential APEC actions. It is important to note that the following conclusions are based on data from only ten economies; and therefore, may not represent a complete picture of SN&C implementation plans in the region.

6.2.1 Implementation Plans

- Implementation of DGPS is progressing in the region as two economies have fully operational networks of DGPS and implementation is underway in four other economies.

- Implementation of ECDIS is progressing more slowly in the region with only four economies currently using the technology; one other economy is beginning its program to support ECDIS.

- Availability of IMO S-57 ENC for the region may prove to be problematic as only four economies have progressed significantly in the development of ENC data although another two are committed to near-term development.

- Satellite communications are currently available in all but two of the eleven economies for which there was information available of communications capabilities.

- A number of APEC economies are currently focussing implementation of GMDSS and not SN&C technologies such as DGPS and AIS.

- The following levels of implementation were assigned to the economies:
  - **High** - Canada and the United States;
  - **Medium** - Australia (Medium-High), China, Hong Kong (Medium-High), Malaysia (Medium-High) and Singapore;
  - **Low** - Chinese Taipei, New Zealand, the Republic of the Philippines, and Thailand; and
  - No assessment - Brunei, Chile, Japan, Indonesia, Mexico, Korea and Papua New Guinea.

- In general, implementation of marine SN&C technologies in the Asia-Pacific region is moving slowly.

6.2.2 SN&C Implementation Issues

- Given the low level of response to this question, the identified key issues may not be representative of the full APEC region.

- The key potential APEC actions that were identified by the member economies were:
  - Cost and Funding (4/5);
  - Standards and Regulations (3/5); and
  - Harmonization and Seamlessness (3/5).

6.2.3 APEC Actions

- Given the low level of response to this question, the identified key APEC actions may not be representative of the full APEC region.

- The key potential APEC actions that were identified by the member economies were:
  - Funding assistance (4/4);
  - Coordination and planning (4/4);
  - Standards and regulations (3/4); and
  - Technical assistance (3/4).

Appendix A

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Appendix B

Interview Framework and Guide

(Not available in electronic format/
Non disponible en format électronique)

Appendix C

Contact List

(Not available in electronic format/
Non disponible en format électronique)

Appendix D

Interview List

Australia

Civil Aviation Safety Authority	
Holger von Muenchausen	General Manager, Flying Operations Branch
Robert Loretan	Manager, Airspace & Aerodromes Section
Ben Scheimer	Flying Operations Inspector, Flying Operations Branch
James Coyne	Principal Engineer, Airworthiness Branch
Australian Maritime Safety Authority	
Rick Burleigh	Controller, Maritime Rescue Coordination Centre
Paul Threfall	A/Manager, Policy & Operational Support
Glen Dunstan	Project Manager, Communication Review
AirServices Australia	
Brian O'Keefe	General Manager, International and ICAO Division
Ken McLeod	Search and Rescue
John Swann	Tech. Specialist & Head, Brisbane Regional Coord. Cnt
Gary Lawson-Smith	Manager, GNSS Program Office
Graeme Crosby	
Mike Gahan	Manager, ATS Requirements, Airspace Mang. & Proc.
Quantas	
Capt. David Massey-Greene	Manager, Technical: B747-400

Canada

Fisheries and Oceans	
Fred Donkor	Economics, Finance and Administration Directorate
Canadian Coast Guard	
Val Smith	Navigation Specialist, Canadian Coast Guard
Transport Canada	
Ron D'Ambrosio	Chair, CNS/ATM Transition WG, ANS Requirements
Captain David Jenkins	Superintendent, Regional Serv. & Sup., Ship Inspection

New Zealand

Ministry of Transportation	
Nigel Mouat	Head, Domestic Air Services
Peter Davey	Co-ordinator, Aviation Policy
Sean Ford	Adviser, International Air Services
Tom Martin	Deputy Director, Maritime Safety Authority

Airways Corporation of New Zealand	
Pete Proulx	CEO, Airways Corp.
Warrick Marriott	Manager, System Group
Air NewZealand	
Capt. Ian Varcoe	CNS/ATM Project Manager, Flight Operations International

Philippines

Department of Transportation and Commerce	
Nonita Silva	Superv Comm. Dev. Officer (coord. of input to APEC TPT)
Balba Rogello	Supervising Communications Development Officer
Brendo C. Elegio	Senior Transport Development Officer
Judith Tabaquin	Supervisor Airways Comm. Services (coord air for APEC)
Belinda C. Salvosi	Senior Communications Development Officer
Philippines Ports Authority	
Carlos Augustin	General Manager
Department of Foreign Affairs	
Federico M. Macaranas	Undersecretary (Chair APEC Senior Officials Meeting)
Antonio I. Basilio	Deputy Chair, APEC-SOM Secretariat

Thailand

Bankog Department Port Authority	
Charin Inmuang	Admin Officer
Ministry of Transportation and Communications	
Sathien Vongvishien	Deputy Permanent Secretary (Head of Delegation to APEC)
Sudanong Charuthus	Director, International Affairs
Preecha Chusup	
Malee Uabharadorn	
Harbour Department	
Krishnee Varanusupakul	Deputy Director General (Program Coord. to APEC TPT)
Dolhathai Totanakun	Marine Environmental Officer
Port Authority of Thailand	
Rapeepan Kongdis	Project & Planning Department
Charin Inmuang	Department Engineer

United States

Federal Aviation Authority	
John Augustine	International Liaison, SATNAV Office
Joan Bauerlein	Director, Office of International Aviation
Herbert Bachner	Manager, International Assistance Division
US Coast Guard	
Cmdr William Cairns	Electronics Engineer
Joseph Hersey	Chief, Maritime Radio and Spectrum Management Div.
RTCA Inc.	
David Watrous	President
Seariver Maritime	
Bob Freeman	Operations Safety and Casualty Response
Innovative Solutions International	
Richard Cole	Director of Washington Operations, Satellite Navigation Div.
ICAO	
Vladimir D. Zubkov	Chief, Regional Affairs Office
Normand Ostiguy	Regional Affairs Officer
Hassan Tehrani	Regional Affairs Officer
Douglas Mein	Air Navigation Commissioner, Permanent Mission of Canada
IMO	
Capt. Fossum	Director of Safety
INMARSAT	
Jim Fehr	

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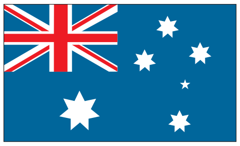
Appendix E

Detailed Country Reports

Australia
Brunei Darussalam
Canada
Chile
China
Hong Kong
Indonesia
Japan
Republic of Korea
Malaysia
Mexico
New Zealand
Papua New Guinea
Republic of Philippines
Singapore
ChineseTaipei
Thailand
United States



Australia


Australia


Wyndham
Daly Waters
Derby
Cairns
Townsville
Dampier
Alice Springs
Rockhampton
Brisbane
Geraldton
Kalgoorlie
Broken Hill
Perth
Esperance
Sydney
Adelaide
Albany
Canberra
Melbourne
Hobart

Australia

General Description

Australia, the world's smallest continent but sixth largest economy, is located in Oceania between the Indian Ocean and the South Pacific Ocean. The land area is approximately 7.6 million square kilometres with a coastline 25 760 km long. The terrain is mostly low plateau with deserts and fertile plains in the southeast. The total population as of July 1995 was 18.3 million.

Being such a large country, only slightly smaller than the U.S., Australia has a significant transportation infrastructure. There are 40 478 km of railroad; 837 872 km of highways; and 8 368 km of inland waterways mainly for small, shallow-draft craft. There are twelve primary ports (Adelaide, Brisbane, Cairns, Darwin, Devonport, Fremantle, Geelong, Mackay, Melbourne, Sydney and Townsville) with two in Tasmania (Hobart and Launceton) and a total of 480 airports (308 paved and 172 unpaved runways).

Trade

Australia has a prosperous capitalist economy. Rich in natural resources, Australia is a major exporter of agricultural products, minerals, metals, and fossil fuels. Primary products account for more than 60% of the value of total exports which was U.S.$ 50.4 billion in 1994. In particular, export commodities include coal, gold, meat, wool, alumina and wheat. Australia's primary export partners are Japan, U.S., South Korea, New Zealand and the United Kingdom. Imports to Australia valued U.S.$ 51.1 billion in 1994 with primary import partners being the U.S., Japan, the United Kingdom, Germany and New Zealand. Import commodities include machinery and transport equipment, computers and office machines, crude oil and petroleum products.

Aviation SN&C Implementation

General Description

Airservices Australia, a government business enterprise, was established in July 1995 and manages approximately 11 percent of the world's airspace. Currently, Australia's airspace is managed as six Flight Information Regions. However with the implementation of The Australian Advanced Air Traffic System (TAAATS) in 1998, the airspace will be managed through two FIRs: The Northern Flight Information Region will be based at the Brisbane Air Traffic Service Centre. It will cover the northern half of the continent and oceans to the north and east. The Southern Flight Information Region will be based at the Melbourne Air Traffic Service Centre and will cover the southern half of the continent and vast areas of the Indian and Southern Oceans. Terminal Control Units in Cairns, Sydney, Adelaide and Perth will provide air traffic control for aircraft within about 45 nautical miles of the airports. Similarly, approaches and departures for Canberra and Melbourne will be handled from the Melbourne TAAATS centre and those for Brisbane and Coolangatta will be handled from Brisbane.

Traffic

Preliminary analysis for major routes to and from Australia indicates projected annual growth rates from 1992 to 1997 of 12.5 percent for Japanese passenger traffic, 6.1 percent for North American traffic, 14.5 percent for South East Asian traffic and 7.2 percent for South American traffic. The trends indicate that traffic on Japanese routes will surpass traffic in the North by 1993. Overall, total international passenger traffic in to and out of Australia has been forecasted to grow by 8.8 percent per annum between 1993 and 2000, and by 7.9 percent between 2000 and 2010. The strongest region of growth, as shown by the above forecast, is expected to be between Australia and Southeast Asia. This is due in part to the anticipated development of regional services between Singapore, Malaysia, Indonesia and secondary airports in Australia.

The highest growth rate of in the past was between Australia and Northeast Asia. In contrast it is predicted to be to and from Southeast Asia in the future. In 1985, this region pair represented 27% of the total traffic but will increase to almost 40% by 2010. The relative importance of Southwest Pacific markets (mainly New Zealand) for Australia will decline in the future, with Singapore emerging as the most important country of origin-destination for traffic by 2010.

Consistent with the passenger growth forecasts and future expectations of load factors and average aircraft size, aircraft movements across the Pacific are expected to increase from an estimated 91 902 in 1993 to over 128 000 in the year 2000, an average annual rate of 4.9 percent for the period. Current estimates indicate that Australian air traffic growth is in the same range with an expected average of 4% a year for the next five years. Tables 1 through 4 present historical data for International airline activity, Major Australian airline activity, Regional airline activity and General aviation activity.

Present & Future Infrastructure

Table 5 presents a summary of the present & future systems for the oceanic and domestic airspaces. Australia has an extensive structure of the standard ground-based systems for communication, navigation and surveillance. As can be seen from Table 5, Australia is planning to implement a full CNS/ATM system using satellite-based systems such as GNSS, AMSS and ADS.

Table 1: Historical Statistics for International Airline Activity

Activity	1991	1992	1993	1994	1995
Number of Operators	42	42	46	49	56
Flights (In & Out)	46 607	50 090	53 694	57 249	64 478
Aircraft Movements	74 018	80 990	87 168	87 956	94 915
Inbound Traffic Passengers ('000)	4 354.0	4 670.5	5 127.8	5 601.3	6 199.7
Seat Availability ('000)	6 651.2	7 143.9	7 742.4	8 201.7	9 265.1
Seat Utilization (%)	66	65	66	68	67
Freight ('000 tonnes)	172	186	198	241	248
Mail ('000 tonnes)	10	10	10	11	11
Outbound Traffic Passengers ('000)	4 298.5	4 637.5	5 050.4	5 531.5	6 090.9
Seat Availability ('000)	6 641.5	7 140.5	7 733.7	8 197.8	9 261.3
Seat Utilization (%)	65	65	65	68	66
Freight ('000 tonnes)	188	220	257	280	302
Mail ('000 tonnes)	7	7	8	8	8

Source: http://www.airservices.gov.au/corp/mayfact5.htm

Table 2: Historical Statistics for Major Australian Airline Activity

Activity	1991	1992	1993	1994	1995
Number of Operators	7	5	3	2	2
Aircraft Movements ('000)	407.1	437.8	453.7	500.7	528.9
Hours Flown ('000)	316.6	344.1	369.2	416.0	na
Kms Flown (millions)	190.7	203.9	219.6	250.0	na
Passengers (millions) Passenger-kms Performed	17 695.9	18 277.1	20 884.6	24 312.5	26 173.9
Revenue Passengers Tonne-kms	1 592.6	1 644.9	1 879.6	2 188.1	2 355.7
Seat-kms Available	23 723.0	23 713.0	27 319.7	32 999.8	36 247.6
Freight ('000 tonnes) Freight	117.1	122.7	150.5	204.0	na
Mail	19.9	22.6	25.0	26.6	na
Load Factor Revenue Passenger (%)	74.6	77.1	76.4	73.7	72.2

Source: http://www.airservices.gov.au/corp/mayfact5.htm

Table 3: Historical Statistics for Australian Regional Airline Activity

Activity	**1991**	**1992**	**1993**	**1994**	**1995**
Number of Operators	40	50	45	45	45
Aircraft Departures ('000)	256.5	277.5	298.5	312.7	314.4
Aircraft Movements ('000)	513.0	555.0	597.0	625.4	628.8
Hours Flown ('000)	193.8	213.7	224.0	236.9	251.3
Kms Flown (millions)	61.9	68.7	73.0	78.5	83.5
Passengers Embarkations ('000)	1793.5	2049.5	2345.4	2712.2	2971.5
Passenger-kms Performed (**millions**)	644.5	749.0	852.2	998.5	1140.0
Revenue Passengers Tonne-kms (**millions**)	58.0	67.4	77.5	89.9	100.2
Seat-kms Available (**millions**)	1266.7	1394.2	1522.2	1744.2	1921.4
Freight ('000 tonnes) Freight	2.8	2.8	2.3	2.4	2.6
Mail	0.1	0.2	0.1	0.1	0.1
Load Factor Revenue Passenger (%)	50.9	53.7	56.0	57.2	58.0

Source: http://www.airservices.gov.au/corp/mayfact5.htm

Table 4: Historical Hours Flown for General Aviation Activity ('000)

Activity	1990/91	1991/92	1992/93	1993/94	1994/95
Private	275.9	256.6	258.8	261.9	248.8
Business	269.1	211.9	214.6	202.7	192.4
Training	468.7	434.9	425.1	434.0	419.1
Agriculture	122.1	91.8	79.0	94.4	80.3
Aerial Work	295.1	268.6	261.7	294.6	294.5
Test and Ferry	30.6	27.8	29.6	26.3	26.9
Charter	366.5	397.6	387.2	413.1	448.3
TOTAL	1828.1	1689.1	1656.1	1727.1	1710.3

Source: http://www.airservices.gov.au/corp/mayfact5.htm

Table 5: Summary of Present and Future Systems

	Communication	Navigation	Surveillance	Air Traffic Management
Present Oceanic Systems (1996)	• CPDLC (Brisbane Sector) • HF Radio Voice • AFTN (Data) • Voice between Oceanic Centres	• GPS • Inertial Navigation Systems • OMEGA • Barometric Altitude	• Voice Position Reporting	• Procedural with computer aided flight plan processing • Paper flight strips • Manual conflict detection • Manual co-ordination between Oceanic Centres • Flexible & Fixed Tracks • 50 mile, 2000 ft separation
Future Oceanic Systems (2010)	• Satellite Voice & Data using the Aeronautical Mobile Satellite Service • Automatic data co-ordination between Oceanic Centres via ATN data network • CPDLC	• Global Navigation Satellite System & Augmentation • Barometric Altitude	• Automatic Dependent Surveillance	• TAAATS • Automatic data co-ordination between Oceanic Centres • Flexible & Dynamic Routing • 30 mile, 1000 ft separation • Required Navigation Performance Procedures
Present Domestic Systems (1996)	• VHF Radio (Voice) • UHF Radio (Voice) • HF Radio • AFTN (message switching & aeronautical database) • ATIS (Voice)	• NDB • VOR • DME • ILS • MLS • Barometric Altitude	• Primary Radar • Monopulse Secondary Radar (Mode A/C) • Voice Reporting •Airport Surface Detection Equipment	• Computer aided flight plan processing • Paper flight strips • Flight Data Displays • Radar Displays • Multi-radar tracking • Fixed Routes • Manual Conflict Detection
Future Domestic Systems (2010)	• VHF Radio (Voice) • VHF air-ground data link • HF Radio • ATN • CPDLC	• Global Navigation System & Augmentation • Barometric Altitude	• Automatic Dependent Surveillance • Possible Primary or Secondary Radar •Airport Surface Detection Equipment	• TAAATS • More flexible, direct & dynamic routing • Required Navigation Performance/ RNAV

Sources: Asia/Pacific Regional Plan for the New CNS/ATM Systems, Issue 4, Amendment No.1
http://www.airservice.gov.au

Highlights of Current SN&C Work

Airservices is playing a prominent role in the implementation of CNS/ATM in the Asia-Pacific region. Australia is currently modernizing its air traffic control facilities and preparing for the global introduction of CNS/ATM. At the same time, Airservices is working closely with many of the economies including (but not limited to) China, Indonesia, New Zealand, Papau New Guinea, the United States, and Vietnam; and is actively involved in ICAO (including the APANPIRG CNS/ATM Implementation Coordination Sub Group) and other regional groups such as the GNSS Implementation Team (GIT).

Current highlights of SN&C work includes:

- As of July 1996, providing CPDLC service for the Brisbane Oceanic Sector for suitably equipped aircraft. The introduction of CPDLC will enable the implementation of a reduced 50 nm separation standard and more flexible route tracking.

- Working closely with New Zealand and Indonesia to agree on the implementation plans for the Air Traffic Services Intrafacility Data Communications (AIDC) standards-based data exchanges. This will ensure harmonization of data transfer as flights transit between the three airspaces.

- Awarding a contract to undertake a Global Navigation Satellite System (GNSS) augmentation systems audit and cost benefit analysis for Australian civil aviation.

- Joining forces with New Zealand and the United States to develop an Augmentation Systems Test Bed (ASTB) in Australia during 1996/97. The aim of the ASTB is "to improve the integrity of GPS and GLONASS systems to support sole-means en-route, non-precision approach and, where the appropriate, differential corrections are provided, Category 1 precision approach requirements."

- Implementing TAAATS which will come into operation in 1998 and harmonize with other nations' air traffic management systems and will put Australia in a prime position for the introduction of CNS/ATM.

SN&C Implementation Plans

Airservices has been playing a key role in the implementation of SN&C technology in the region. In recent years Australia has been actively involved in ICAO and other regional meetings to promote and agree on the procedures and schedules for the introduction of new systems. Australia committed to implement ADS and has been conducting ADS trials with Qantas, Air New Zealand and United Airlines. Airservices began provision of Controller Pilot Data Link Communications (CPDLC) services for the Brisbane Oceanic Sector in July 1996. The implementation of CPDLC is a critical step in the transition to ADS and will allow reductions in separations.

This economy is also moving rapidly towards a full implementation of GNSS and its augmentation. Supplementary en route and non-precision approaches were introduced in 1995. A GNSS augmentation test bed is to be established in 1996/97 and is complementary to Australia's GNSS Augmentation Systems Audit and Cost Benefit Analysis. The results of both exercises are expected to be used to assist the APANPIRG, other Asia Pacific states and possibly other regions with their CNS/ATM, and in particular GNSS, planning efforts.

In the area of ATM, TAAATS will come into operation in 1998 providing the first fully integrated air traffic control system for Australian airspace. TAAATS fully complies with worldwide agreement, through ICAO, to move to a unified system for communication, navigation and surveillance largely based on satellites. This will allow the development of air traffic management systems that enhance safety, reduce delays, accommodate increasing traffic densities, allow more economical route planning and generally reduce operating costs.

Level of SN&C Implementation (High, Medium, Low)

Australia is considered to have a high level of implementation. With the implementation of CPDLC, Australia will reduce separations and implement flexible routing and is well on the way to implementing ADS in the Oceanic Sectors. This economy is committed to the development and implementation of satellite-based navigation. It has approved the supplemental use of GPS , is moving forward on the development and implementation of stand-alone GPS non-precision approaches, and is implementing the ASTB.

Australia is actively involved in many CNS/ATM working groups, committees and implementation teams and is working very closely with other economies to ensure harmonization and provide assistance. Based on implementation plans, Australia currently has initial operations of all elements of the SN&C technologies except for wide area augmentation of GNSS; but assessment of this technology is well under way.

Issues Identified

Australia identified the following issues regarding transition to SN&C:

- A seamless system is required not only within the Asia-Pacific region but also between regions. In particular, approaches to and flights over India have been a principal choke point. Also of importance is the Russian Far East region. It is important to note that ICAO has scheduled a conference to set up inter regional coordination in early 1997.

- Over investment in CNS/ATM is a potential danger.

Potential Actions Identified

Australia identified the following actions to reduce or eliminate transition issues:

- APEC

  - Encourage Transport Ministers to work together with their cabinet colleagues who are responsible for communications in the ITU to ensure that protection of spectrum allocations are continued until CNS/ATM is a global reality.

  - Obtain an endorsement from the Transport Ministers for the ICAO APANPIRG Plan and in general, reinforce member economies' support for their CNS/ATM committees thereby promoting the use of CNS/ATM in the APEC region.

  - Play a main role in the coordination of implementation in the region.

  - Provide funding and technical assistance.

  - In consultation with ICAO, provide assistance to meet identified training and information exchange requirements for the implementation of CNS/ATM in the region.

  - Provide support for the implementation of ICAO and industry standards throughout the region.

Marine SN&C Implementation

General Description

The Australian Maritime Safety Authority (AMSA) is a largely self-funded safety agency with the charter of enhancing efficiency in the delivery of safety and other services to the Australian maritime industry. AMSA aims to enhance the safety of seafarers and shipping and to protect the marine environment from pollution. The geographic area of responsibility of AMSA covers one-ninth of the earth's ocean area, some 47 million square kilometres stretching halfway to South Africa in the west, New Zealand in the east, to the Antarctic coastline in the south and Indonesia and PNG to the north.

Traffic

While ship arrivals at Australian ports remained fairly constant between 1989 and 1993 with 8 444 and 9 342 respectively, ports have since seen an increase in the tonnage shipped. Increases of as much as 56% have been experienced at some ports. Data which was collected as part of the Trade and Traffic portion of the APEC SN&C Study is presented in two tables: Table 6 presents the ship arrival data and Table 7 presents the tonnage data.

Table 6: Summary of Ship Arrivals for Selected Ports

Port	Number of Ship Arrivals					Average
	1989	1990	1991	1992	1993	
Geelong	350	369	452	458	351	396
Gladstone	575	590	676	690	670	640
Hedland Port	746	755	682	575	617	675
Hobart, Tasmania	490	504	467	580	590	526
Launceston	479	445	----	520	554	500
Melbourne	2 640	2 655	2 569	2 518	2 610	2 598
Newcastle	1 037	1 003	1 176	1 217	1 275	1 142
Port Kembia	525	528	614	469	----	534
Sydney Port	1 602	1 735	2 340	2 206	----	1 971

Source: Shipping Statistics Yearbook, 1994 Institute for Shipping Economics and Logistics (ISL) Breman, Germany.

Table 7: Summary of Shipping Tonnage for Selected Ports

Port	Average Ship Size	Maximum Ship Draught	Unit	Shipping Tonnage (in 1000)				
				1989	1990	1991	1992	1993
Geelong	21 610	----	grt	7 071	5 956	7 126	6 286	7 585
Gladstone	35 373	18	grt	21 463	21 100	23 696	24 526	23 700
Hedland Port	45 867	----	grt	21 364	21 411	25 095	25 065	28 300
Hobart Tasmania	8 259	----	grt	4 660	4 547	4 750	4 720	4 873
Launceston	11 101	----	grt	6 015	----	----	6 228	6 150
Melbourne	13 885	----	grt	33 375	34 719	33 996	34 658	36 239
Newcastle	27 459	15	grt	28 475	----	----	----	----
Port Kembia	41 791	----	grt	15 281	15 961	18 050	19 600	----
Sydney Port	18 400	----	grt	25 912	25 571	39 930	40 590	----
Port of Touranga	11 733	12	grt	5 856	6 962	8 445	9 244	10 243
Wellington	7 003	----	grt	18 181	----	19 902	----	-----

grt = gross register tonnage, nrt = net register tonnage

Source: Shipping Statistics Yearbook, 1994 Institute for Shipping Economics and Logistics (ISL) Breman, Germany.

Present & Future Infrastructure

As of 30 June 1996 the Australian aids to navigation network comprised a total of 393 aids consisting of the following:

- 10 attended light stations;
- 291 unattended light stations;
- 11 auxiliary visual aids;
- 2 light vessels;
- 33 lighted buoys;
- 8 unlit beacons;
- 31 racons (radar transponder beacons);
- 4 radio reporting tide gauges;

- 1 Omega navigation system transmitter; and
- 3 DGPS Broadcasting stations.

Australia operates one of the eight transmitting stations comprising the worldwide Omega navigation system which is to be terminated on 30 September 1997.

Currently, AMSA does not provide any Vessel Traffic Services. There are plans to provide VTS in the Great Barrier Reef area and possibly in the Sydney and Melbourne port areas. The move towards AIS has been started by the Australian Fish Management Agency (30 vessels fitted to date for fish management purposes). It is anticipated that Australia will implement an AIS.

Currently communications are provided by a variety of technologies:

- Telstra contract for Morse, voice and Digital Selective Calling (DSC) transmissions and listening;

- HF radio and HF commercial radio phone;

- VHF radio and VHF commercial sea phone;

- INMARSAT A, B, C, E, M and P;

- Mobile satellite systems; and

- Link to AFTN.

In the future, the focus will be on the use of satellite communications such as INMARSAT and other mobile satellite systems. The requirement for transmission of data will be met primarily by satellite communications. The GMDSS also makes use of INMARSAT.

Australia has full implemented the GMDSS which incorporates traditional and satellite communication technologies. The Maritime Rescue Coordination Centre is one of three centres worldwide receiving distress alerts on the INMARSAT-E system.

Highlights of Current SN&C Work

AMSA has established three Differential GPS Broadcasting Stations, one at Cape Schanck, Victoria, one at Karatha, Western Australia and one at Horn Island in the Torres Strait. Planning continues for the possible establishment of further DGPS Broadcasting stations to cover the more critical areas around the Australian coast. A specification has also been prepared for the procurement of any stations which may be included in future capital work programs.

AMSA has continued to work closely with the Department of Defence which is undertaking significant work to develop an ENC capability. A policy paper was presented which identifies a Defence Major Project aimed at supporting the Australian Defence Forces digital data needs for the future and also meeting the potential commercial requirements of the industry in regard to electronic charting and ECDIS with a funding requirement of $50m and a five year program commencing in 1996-97.

AMSA and the Australian Hydrographic Office are working together to develop the capability to produce ENC and other digital products. With the paucity of national and international ENC data compliant to IMO standards, these two organizations are also facilitating the commercial availability of non-compliant Electronic Chart Systems (ECS) to satisfy the shipping industry's immediate requirements.

SN&C Implementation Plans

AMSA will continue with its adoption and use of SN&C technologies. Australian activities include:

- Planning for establishment of additional DGPS broadcasting stations;
- Continuing work in the development of an ENC database;
- Continuing work in the development and implementation of ECDIS; and
- Continuing support for provision of ECS.

Level of SN&C Implementation (High, Medium, Low)

Australia has a medium to high level of implementation for the following reasons:

- Have implemented three DGPS stations.
- Have developed plans for the implementation of further DGPS stations.
- Have begun development of an ENC database.
- Have begun investigation into the implementation of ECDIS.
- Are supporting the use of ECS.

Issues Identified

Potential issues that may impact the implementation of SN&C technologies in a marine environment include:

- The cost of the systems to both providers and users.

- User, particularly recreational vessels, acceptance, demand for and implementation of SN&C technologies.

- Sovereignty, national security and political will.

- Scope for the wide area augmentation systems being developed for aviation applications to be utilised for maritime and land applications.

- Arrangements for the management and funding of Government provided wide area augmentation systems.

- Technical, management, planning, institutional and funding aspects relating to a proposed future internationally controlled GNSS for civil applications.

Potential Actions Identified

Interviews with AMSA personnel brought forward the following actions that may assist with the implementation of SN&C technologies:

- APEC could encourage cooperation and assist with the provision of funding and technical assistance including training.

- APEC could play a prominent role with coordination and planning in the region. In particular, coordination is required in the area of availability, accessibility, commonalities and currency of databases.

- Disseminate up-to-date information throughout the APEC region on the status of:

    - Wide area augmentation systems designed to overcome the integrity warning and accuracy limitations of GPS and GLONASS;

    - Other systems (mainly local area augmentation systems) designed to provide augmentations to GPS and GLONASS such as marine radio beacon DGPS services; and

    - Activities (particularly IMO and ICAO) relating to the development of proposed future internationally controlled GNSS for civil applications.

- Encourage relevant Government organisations in the APEC region to participate in the development and trials of wide area augmentation systems.

- Examine options for the institutional and funding arrangements for a proposed future internationally controlled GNSS for civil applications. (This examination would concentrate on the APEC region, but would have regard to European and worldwide developments proceeding in other fora.)

Data Sources

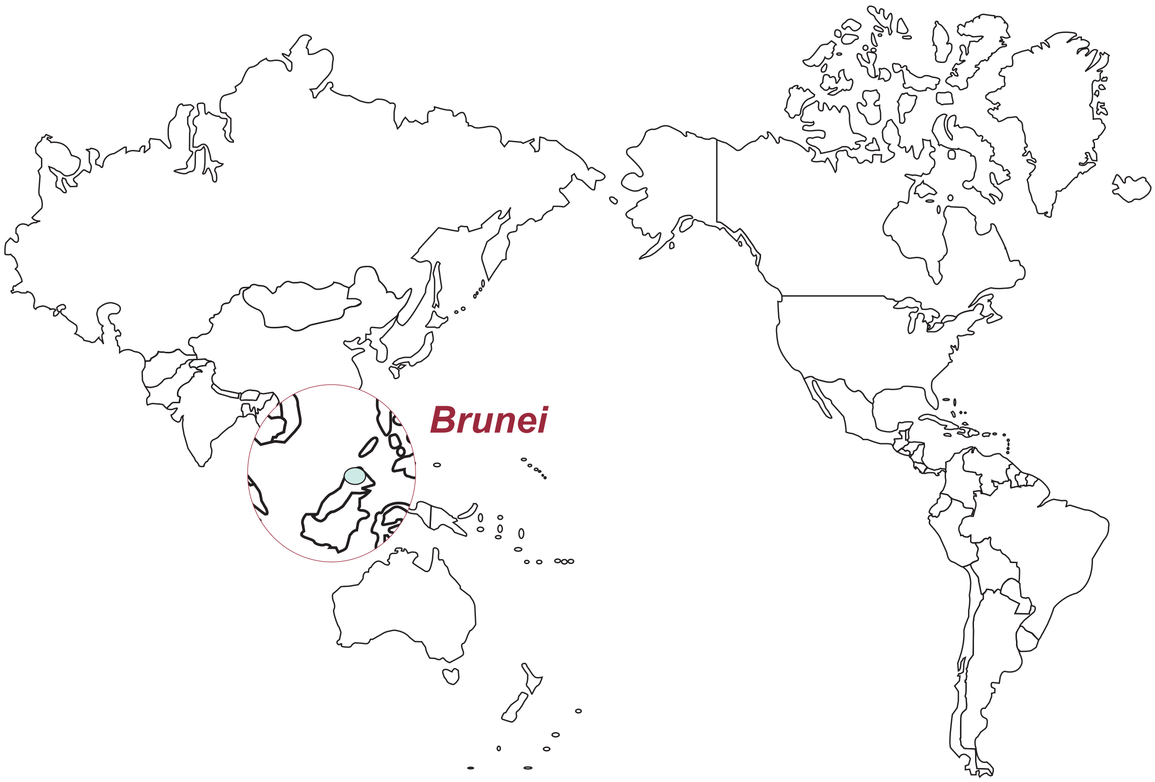
A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/as.html" was used.

- The following documentation on the Australian aviation sector has been collected:
  - Background information, articles and statistics from the Airservices web site, "http://www.airservices.gov.au"
  - Interview Notes to Framework Questionnaire
  - Response to SN&C Project Request for Possible APEC action from Transport and Regional Development
  - Article from ATC News (27 May 1996) entitled "Augmentation test bed for Australia"
  - Asia/Pacific Regional Plan for the New CNS/ATM Systems, Issue 4, Amendment No.1
  - Civil Aviation Authority Australia Annual Report 1994-95

- The following documentation on the Australian marine sector was collected:
  - Shipping Statistics Yearbook, 1994 Institute for Shipping Economics and Logistics (ISL) Breman, Germany
  - Australian Maritime Safety Authority Annual Report (1994-95)
  - Interview Notes responding to framework questionnaire
  - Response to SN&C Project Request for suggestions on possible APEC actions from AMSA
  - AMSA SAR Pamphlets

Brunei



Brunei Darussalam

General Description

Brunei Darussalam is located in southeastern Asia bordering the South China Sea and Malaysia. It consists of two enclaves separated from each other by the Limbang River valley which is part of Malaysia. The land area is approximately 5.3 thousand square kilometres with 161 km of coastline. The terrain consists of flat coastal plains rising up to mountains in the east and hilly lowlands in the west. The total population as of July 1995 was estimated at 292.3 thousand.

With a small land area, Brunei has a limited transportation infrastructure consisting of: 13 km of private rail line; 422 km of paved and 720 km of unpaved highways; and 209 km of inland waterways navigable by craft drawing less that 1.2 metres. There are five primary ports which are located at Bandar Seri Begawar, Kuala Belait, Muara, Seria and Tutong. There are also five airports (four with paved runways and one with unpaved runways).

Trade

The economy of Brunei is a mixture of foreign and domestic entrepreneurship, government regulation and welfare measures, and village tradition. It is almost totally supported by exports of crude oil and natural gas with revenues from the petroleum sector accounting for more than 40% of the GDP. Estimates for 1993 put exports at U.S.$ 2.2 billion and imports at U.S.$ 1.2 billion. The main trading partners for exports, which are primarily crude oil, liquefied natural gas and petroleum products, were Japan, South Korea, the United Kingdom, Thailand and Singapore. Machinery and transport equipment, manufactured goods, food and chemicals are the major import commodities and were obtained primarily from Singapore, the United Kingdom, the United States, Japan, Malaysia and Switzerland.

Aviation SN&C Implementation

General Description

The Department of Civil Aviation within the Ministry of Communications is responsible for managing Brunei's airspace. Brunei has a small airspace, approximately 2,400 square kilometres with all but 400 square kilometres under control of the TMA. The CAA is responsible for three airports, one international which has a control tower and two domestic.

Traffic

No traffic data was available.

Present & Future Infrastructure

Brunei's air navigation system currently relies on conventional ground-based systems. The current systems are VHF voice, NDB, VOR/DME, MSSR, PSSR and ILS. Brunei has not implemented any SN&C systems to date but is working towards a transition to these systems. SN&C implementation plans include transition to satellite communications and VHF and Mode S data link. Plans also include the decommissioning of the NDBs and VORs which indicate that Brunei will likely connect with a regional GNSS augmentation system. The economy has no plans to implement its own system. Brunei has no requirement for ADS and as such, has no plans to implement the system (unless their airspace is expanded beyond the current radar coverage). ATM automation is currently scheduled for implementation as well. Table 1 summarizes the current and future infrastructure of Brunei's air navigation system.

Highlights of Current SN&C Work

Current SN&C work is focussed on planning for the implementation of SN&C technologies. In particular, Brunei is working towards implementing a full ATM system in early 1997. In conjunction with this work, planning is underway for a joint radar tracking arrangement with Kota Kinarula.

SN&C Implementation Plans

Current schedules indicate that transition to GNSS will be completed by 2002 with the decommissioning of NDBs by 2000 and VOR/DMEs by 2003. The primary radar will be phased out by 2001; SSR Mode A/C will continue; and A Mode S radar will be implemented by 2001 providing both surveillance and data link capabilities. VHF data link will also be operational by 2001.

Level of SN&C Implementation (High, Medium, Low)

Brunei is considered to have a low to medium level of implementation. Given their airspace requirements, the economy needs to implement a basic system. While they have begun planning for transition to SN&C , Brunei has not yet implemented any components. Based on current implementation plans, Brunei will have initial operations of the SN&C technologies by 2003.

Issues Identified

Potential issues that may impact implementation of SN&C technologies in Brunei are:
- Sovereignty;
- National security;
- User acceptance;
- Availability of regulations and standards;
- Institutional and legal factors;
- Limitations of current infrastructure;
- Availability of funding; and
- Training of air traffic controllers.

Potential Actions Identified

Brunei indicated APEC may have a role, in close consultation with ICAO, in establishing a multi-agreement among states with regards to airspace structure.

Table 1: Current and Present ANS Infrastructure

Conventional Equipment/ Capability	Airspace where the Equipment/ Capability is Currently Used: Route	Terminal/ Approach Control	Airport/ Aerodrome Control	CNS/ATM Equipment/ Capability	Airspace where the Equipment/ Capability is Currently Used: Route	Terminal/ Approach Control	Airport/ Aerodrome Control
Ground Comm Links		○	○	Satellite Communications	○		
HF voice[1]	○			VHF Data Link[4]	○		
VHF voice	●/○	●/○	●/○	HF Data Link			
Omega				SSR Mode S Data Link	○		
NDB[2]	●	●		SSR Mode S Surveillance	○	○	
VOR[3]	●	●		DGNSS			
DME	●	●		LAAS			
Primary Radar	●/○	●/○		RAS/MSAT			
SSR Mode A/C	●/○	●/○		ADS			
ILS			●/○	ATM Automation[5]	○	○	○
MLS				Other (Please Specify)			
VASIS/PAPIS			●/○				
Other (Please Specify)							

Source: Economies Response to Questionnaire

● Current Infrastructure ○ Future Infrastructure ●/○ Both Current & Future Infrastructure

1 For Marine SAR.
2 Slowly withdrawn by 2000.
3 Slowly withdrawn by 2003.
4 Implemented by 2001.
5 Implemented by early 1997.

Marine SN&C Implementation

No Information has been supplied to-date.

Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/bx.html" was used.

- The following documentation on Brunei aviation has been collected:
  - Response to Framework Questionnaire and Survey.

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Canada


Canada


Whitehorse
Yellowknife
Goose Bay
Churchill
St. John's
Edmonton
Vancouver
Fredericton
Quebec
Halifax
Winnipeg
Montreal
Ottawa
Toronto

Canada

General Description

Canada, the world's second largest country, lies in northern North America and is bounded on the east by the Atlantic Ocean, on the west by the Pacific Ocean, on the North by the Arctic and on the south by the United States. The land area is approximately 9.2 million square kilometres with a coastline 243 791 km long. The terrain is mostly plains with mountains in the west and lowlands in the southeast. The total population as of July 1996 was 30.0 million of which nearly 90% is concentrated in the region near the U.S./Canada border.

Due to the vastness of Canada, the transportation infrastructure is significant. There are two major transcontinental freight railway systems and a passenger service which use a total of 78 148 km or railroad. There are 849 404 km of highways of which 253 692 km are paved. Canada has an extensive inland waterway system which is 3 000 km long and includes the St. Lawrence Seaway. There are 15 primary ports and over 1 000 airports.

Trade

As an affluent high-tech industrial society, Canada closely resembles the United States in per capita output, market-oriented economic system, and pattern of production. The economy, rich in natural resources, is a major exporter of agricultural, energy and forestry products along with minerals and metals. In 1995, exports amounted to U.S.$ 179.6 billion with imports of U.S.$ 159.6 billion. Key import commodities include machinery and equipment, automotive products and consumer goods. The United States is Canada's main trading partner with 75% of imports coming from, and 79.7% of exports going to the U.S. Table 1 presents data on trading partners while Table 2 summarizes imports and exports by commodity.

Table 1: Summary of Imports and Exports by Trading Partner (CD$ billion)

Trading Partner	Imports			Exports		
	1993	1994	1995	1993	1994	1995
United States						
Value (CD$ billions)	125.8	151.7	168.9	144.9	177.4	202.0
Percent	73.2	74.8	75.0	79.9	81.4	79.7
Japan						
Value (CD$ billions)	8.4	8.3	8.4	8.2	9.4	11.5
Percent	4.9	4.1	3.7	4.5	4.3	4.5
European Union						
Value (CD$ billions)	13.9	16.2	20.0	11.0	11.3	15.9
Percent	8.1	8.0	8.9	6.1	5.2	6.3
Other Organisation for Economic Cooperation and Development excluding U.S., Japan and EU Countries						
Value (CD$ billions)	4.6	7.3	7.8	3.1	4.2	4.3
Percent	2.7	3.6	3.5	1.7	1.9	1.7
Other Countries						
Value (CD$ billions)	19.2	19.6	20.3	14.0	15.6	20.2
Percent	11.2	9.7	9.0	7.7	7.2	7.9

Source: http://www.statcan.ca/...rnational/gblec02a.htm & gblec02b.htm

Table 2: Summary of Imports and Exports by Commodity (CD$ billion)

Commodity	Imports			Exports		
	1993	**1994**	**1995**	**1993**	**1994**	**1995**
Agricultural & Fishing Products	11.0	12.6	13.4	15.7	18.0	20.0
Energy Products	7.0	7.0	7.3	18.0	19.4	20.8
Forestry Products	1.6	1.8	2.0	23.1	28.4	35.6
Industrial Goods & Materials	31.1	38.5	45.0	31.0	37.9	46.9
Machinery & Equipment	53.2	65.6	75.6	36.5	46.6	56.3
Automotive Products	40.2	48.4	50.5	48.1	56.6	61.6
Other Consumer Goods	21.4	23.5	25.6	5.0	6.2	7.5
Special Transactions Trade	4.3	4.9	5.5	3.9	4.9	5.4
Unallocated Adjustments	2.2	0.7	0.6	0.0	0.0	-0.2
Total	**171.9**	**203.0**	**225.4**	**181.3**	**217.9**	**253.8**

Source: http://www.statcan.ca/...rnational/gblec04.htm & gblec05.htm

Aviation SN&C Implementation

General Description

The responsibility for the air navigation system in Canada has recently been transferred from Transport Canada, a government department, to Nav Canada, a not-for-profit organization. Instrument Flight Rules (IFR) control service is provided to departing, arriving and en route IFR aircraft and Controlled Visual Flight Rules (CVFR) aircraft operating within specific control areas. Nav Canada provides this service from one Oceanic Control Centre and six domestic Area Control Centres each serving an FIR. Two stand-alone Terminal Control Units also provide these services at the Ottawa and Calgary airports. There are currently 44 air traffic control towers and 91 flight service stations.

Traffic

The number of total enplaning and deplaning passengers at all reporting airports is forecast to be almost 66 million in 1995, representing a 5.9 percent increase from the 62.3 million in 1994. The average annual growth for the period, 1994 to 1999, is forecast at 3.5 percent. Table 3 presents historical data from 1990 to 1994 and forecast data for 1995 to 2007 for the three sectors, Domestic, United States and Other International. It is important to note that it is anticipated that for Canada the Asia-Pacific market will grow much faster than the European market.

The number of total itinerant aircraft movements at all tower airports is forecast to be 3.44 million in 1995, representing a 3.4 percent growth from the 3.33 million in 1994. For the forecast period, 1995-1999, total aircraft movements will increase on average 1.9 percent per year. For 1999, the forecast shares of aircraft movements by sector are: domestic, 76.8 percent; United States, 19.5 percent; and other international, 3.7 percent. The average rate of growth during the forecast period by sector are: domestic, 1.8 percent; United States, 1.8 percent; and other international, 3.3 percent. Table 4 presents historical aircraft movements for 1990 to 1994 and forecast data for 1995 to 2007.

Total air cargo for Canada grew at an average annual rate of about 2.3 percent from 1990 to 1994 for a total of 712 680 tonnes in 1994. From 1994 to 2007 the average annual growth rate is expected to be 3.9 percent for 1 174 600 tonnes in 2007. A number of factors contribute to an increasing demand for air cargo in the future, and in particular the burgeoning economy of the Pacific Rim.

Table 3: Enplaned/Deplaned Revenue Passenger Forecasts (millions)

Year	Domestic	United States	Other Int'l.	Total
1990	45.61	13.70	7.62	66.93
1991	40.92	12.55	7.22	60.69
1992	40.97	13.15	7.92	62.04
1993	39.35	13.61	8.33	61.29
1994	39.80	13.51	8.95	62.26
1995	41.72	14.34	9.85	65.91
1996	42.39	15.17	10.29	67.85
1997	43.12	15.93	10.57	69.62
1998	44.06	16.79	10.85	71.70
1999	44.98	17.70	11.13	73.81
2002	48.86	20.75	13.33	82.94
2007	53.68	24.53	16.35	94.56

Source: Aviation Aggregate Demand Indicators, April 1996, TP 9589E, pg. 12

Table 4: Itinerant Aircraft Movement Forecasts (thousands)

Year	Reporting Carriers				Non-Reporting Carriers	General Aviation	Grand Total
	Domestic	United States	Other Int'l.	Total			
1990	1 308.1	211.5	44.7	1 564.3	1 041.5	1 152.7	3 758.5
1991	1 226.4	202.5	42.6	246.1	859.5	1 156.6	1,106.6
1992	1 227.7	218.6	45.5	1 491.8	804.3	1 119.8	3 415.9
1993	1 142.5	223.4	46.4	1 412.3	774.8	1 107.7	776.8
1994	1 130.6	223.1	50.0	274.1	810.9	1 114.8	3 329.4
1995	1 191.2	246.6	53.8	1 491.6	832.3	1 117.7	3 441.6
1996	1 209.5	265.2	56.3	322.5	854.3	1 120.6	1,177.8
1997	1 229.6	283.1	57.9	342.0	876.9	1 123.5	3 571.0
1998	1 254.4	303.0	59.6	1 617.0	900.1	1 126.4	3 643.5
1999	1 278.5	323.9	61.2	1 663.6	923.9	1 129.4	3 716.9
2002	1 322.0	388.5	76.2	1 786.7	999.1	1 129.2	3 915.0
2007	1 412.4	465.6	92.7	1 970.7	1 138.4	1 153.1	4 262.2

Source: Aviation Aggregate Demand Indicators, April 1996, TP 9589E, pg. 22

Present & Future Infrastructure

The present ANS infrastructure in Canada is extensive in order to provide services across such a vast land area. There is a large network of NDBs, VOR/DMEs, and ILSs to provide navigation and landing aid. The implementation of SN&C, and in particular, WAAS will allow this economy to significantly reduce the number of ground-based navigational aids. While Canada does not have responsibility for Oceanic Airspace in the Pacific, the economy plays a critical role in the North Atlantic. As such, there are plans to implement ADS in this airspace and possibly the more remote airspace in northern Canada. Table 5 presents a summary of the present and future systems for Canada's oceanic and domestic airspaces.

Highlights of Current SN&C Work

This economy is actively involved with SN&C implementation. Canada has formed a CNS/ATM Planning Working Group as a focal point for planning and co-ordinating the introduction of the new CNS technology. Canada has and continues to actively participate in numerous ICAO panels and other regional meetings to promote and agree on the standards, procedures and schedules for SN&C implementation.

The economy is committed to the early implementation of satellite navigation. The economy has approved GPS for en route navigation and has enabled the limited use of GPS for non-precision approaches. Canada will be connected to the United States WAAS and is working closely with the U.S. on its implementation. Four test Wide Area Reference Stations have been established in Canada (Gander, Ottawa, Winnipeg, and Vancouver). These, as well as a network of stations in the U.S., are linked to a testbed Master Station in Atlantic City. Canada and the U.S. are involved in a vigorous campaign to determine and assess WAAS performance for all phases of flight.

In the North Atlantic, numerous trials of all aspects of ADS have been ongoing for several years, and are expected to continue for several more with growing focus on validation of standards and implementation. Canada has undertaken many development projects to evaluate the performance of various ATN sub-networks with simulated ADS and two-way datalink messages, test interim standards (and potentially develop new ones) associated with providing basic ADS services.

Table 5: Summary of Present and Future Systems

	Communication	Navigation	Surveillance
Present Oceanic Systems (1996)	• HF Radio • AFTN (Data) • Voice between Oceanic Centres	• Inertial Navigation Systems • OMEGA/LORAN-C • Barometric Altitude	• Voice Position Reporting • Some Monopulse Secondary Radar
Future Oceanic Systems (2010)	• HF Radio • Satellite Voice & Data • Automatic data co-ordination between Oceanic Centres via ATN data network	• Global Navigation Satellite System • WAAS • Barometric Altitude	• Automatic Dependent Surveillance
Present Domestic Systems (1996)	• VHF Radio (Voice) • UHF Radio (Voice) • HF Radio • AFTN (message switching & aeronautical database) • ATIS (Voice) • National voice switching and data switching systems	• NDB • VOR • DME • ILS • Barometric Altitude • GPS Enroute, Terminal, NonPrec. Supplemental	• Primary Radar • Monopulse Secondary Radar (Mode A/C) • Voice Reporting • Airport Surface Detection Equipment
Future Domestic Systems (2010)	• VHF Radio (Voice) • air-ground data link • UHF Radio (Voice) • HF Radio • ATN	• Global Navigation Satellite System • WAAS • LAAS • Barometric Altitude	• Secondary Radar • Airport Surface Detection Equipment • Possibly Automatic Dependent Surveillance

Source: CNS/ATM Transition and Implementation Plan, January 1995

SN&C Implementation Plans

Table 6 presents the SN&C implementation plans for Canada. This table presents the plans for both the present and proposed systems. It is important to note that the implementation dates indicated are for initial operational capabilities and these capabilities may be available only in portions of the airspace.

Level of SN&C Implementation (High, Medium, Low)

Canada is considered to have a high level of implementation. They have developed a comprehensive CNS/ATM transition and implementation plan that describes both the present and future ANS systems and presents priorities, objectives and activities for implementing CNS/ATM. The economy is vigorously pursuing implementation and approval for GNSS and WAAS as the sole means of navigation in both domestic and oceanic airspace. Canada is also conducting critical trials and demonstrations of ADS in the North Atlantic with implementation scheduled for 1998. Based on the current implementation plans, Canada will have initial operations of all elements of the SN&C technologies by 2000.

Table 6: SN&C Implementation Plans

Element	Existing	Retired	Planned	Implemented
Communication	VHF Voice HF Voice UHF Voice AFTN	– – – –	CPDLC Oceanic/Domestic AMSS Data Link (ATN) AMSS Voice ATN Oceanic/Domestic	1998/2005 1998 ? 1998
Navigation	384 NDB 122 VOR/DME 111 ILS 2 MLS GNSS Supplemental	2005 - 2010 2005 - 2010 – – 2000	GNSS Primary/Sole En route, Terminal, NPA GNSS Primary/Sole CAT I GNSS Sole CAT II/III	2000/2002 2000/2002 2002
Surveillance	41 PSR & SSR Mode A/C	---	ADS CNS-1 Oceanic ADS CNS-1 Domestic	1998 2005

Source: CNS/ATM Transition and Implementation Plan, January 1995

Issues Identified

Canada identified the following issues regarding the transition to SN&C:

- The requirement of appropriate training programs and tools for both operations and maintenance of the SN&C systems.
- Timely development of operational and technical requirements and associated standards are required to ensure that different standards do not result in a plethora of equipment, both avionics and the ground infrastructure.
- Human factors relating to human-machine interface need to be addressed adequately to ensure safety.
- Need to rationalize the number of GESs within the regional area of operations.
- Globalization of navigation systems require worldwide consensus on database issues/standards to ensure accuracy and integrity in the databases.
- User equipage and the resulting ATM requirements to deal with mixed capabilities within the same airspace.

Potential Actions Identified

Canada identified the following actions to reduce or eliminate transition issues:

- APEC

  - Assist/intervene at the political level to encourage regional adoptions of SN&C technology and support their implementation committees.

  - Be aware of and support the activities of ICAO and other international organizations.

  - Assist ICAO with promoting, planning, establishment and funding of training programs.

  - Play a role in the development of cooperative arrangements, address funding requirements and mechanisms, facilitate ICAO SARPS implementation, and facilitate ATM implementation in the region.

  - Provide assistance and funding, to economies who may require it, for transition to WGS84.

Marine SN&C Implementation

General Description

The Canadian Coast Guard is responsible for, among other things, providing navigational services, communication and traffic services, and search and rescue in Canadian waters. Marine Aids and Waterways provide, operate and maintain a system of short-range aids to navigation, long-range aids to navigation, and development and maintenance of commercial waterways, as well as ensuring protection of the public right to navigation. The Maritime Communications and Traffic Management Services provide safety and public correspondence communications and vessel traffic management and regulation. Information and intelligence on the movement of vessels in Canadian waters is provided to other government agencies. Rescue and Environmental Response provide marine search and rescue and emergency preparedness capabilities; promote boating safety to the marine public; and responds to pollution incidents from shipping through oversight of private-sector clean-up or response management depending on incident severity.

Traffic

Marine traffic consists of commercial users, the fishing industry, ferry services , the cruise industry and recreational users. Freighters and ferries prevail as the largest commercial vessel population to which the Coast Guard provides services. In fact, in 1993 freighter and ferry movements totalled 30 thousand and 14 thousand in number respectively and, when combined, accounted for over half the total vessel movements by type. During this period, Coast Guard's Pacific Region provided services for more than one-third (117 million) of all waterborne tonnage moved into, within and out of Canada. The commercial fishing industry is another significant user of Coast Guard navigational aids, communications and ice breaking services. In 1993, there were 36.5 thousand fishing vessels with under one-third of these vessels found on the west coast.

Table 5 below shows the tonnages of international marine traffic imported or exported at Canadian west coast ports. When reviewing the data in this table the following points should be noted:

- Source of data is Statistics Canada, 1994; and
- Only large flows are considered, that is more than 20 000 tonnes per year of a commodity between a Canadian port and a region of the world.

From the table it can be seen that the total tonnage shipped out of western coast ports of Canada to the Asia-Pacific region (Australia, New Zealand, Far East and Southeast Asia) exceeded 51 million tonnes in 1994. However it is important to note that while other international traffic that does not depart and/or originate from an APEC economy, may still pass through Asia-Pacific waters. This includes all traffic to and from the west coasts of North and South America to such regions as East Africa, the Middle East and East India.

Present & Future Infrastructure

The Coast Guard is responsible for maintaining and providing Marine Navigation Systems in support of all marine traffic. A system of 20 098 buoys and land based aids, including lighthouses and racons, which assist mariners in determining their position in relation to land and hidden dangers, are operated and maintained by Coast Guard. In addition, 71 radio beacons and four Loran 'C' stations provide long range position fixing capability.

Table 5: West Coast International Traffic, 1994 (Tonnes)

World Region	Imported	Exported	Total
Australia -New Zealand	589 346	904 601	1 493 947
Baltic Sea		52 804	52 804
Brazil	48 815	2 679 274	2 728 089
Caribbean and Central America	58 502	22 000	80 502
East Africa		20 969	20 969
East Mediterranean		591 186	591 186
Europe	76 344	3 858 772	3 935 116
Far East	1 052 298	46 848 177	47 900 475
Mexico	479 222	1 487 388	1 966 610
Middle East and East India		2 187 849	2 187 849
North Africa		1 385 892	1 385 892
South America, East Coast		126 539	126 539
South America, West Coast	26 152	1 658 289	1 684 441
Southeast Asia	103 999	2 307 353	2 411 352
West Africa	769 673	492 334	1 262 007
West Mediterranean		780 896	780 896
Total	**3 204 351**	**65 404 323**	**68 608 674**

Source: Statistics Canada, 1994

Vessel Traffic Services (VTS), consisting of 15 centres operating around the clock, seven days a week regulates vessel traffic, provides advice and direction to mariners and screens vessels entering Canadian waters for defects/deficiencies through the mandatory ECAREG-Eastern Canada and voluntary NORDREG- Arctic Canada and the voluntary VTS offshore in Western Canada. The provision of distress and safety communications service, broadcasting of weather, and navigational safety and ice information is accomplished via a network of 30 staffed and 148 remotely controlled transmitting and receiving sites.

The future infrastructure will be based on:

- A limited system of buoys and land based aids, including lighthouses and racons;

- A DGPS system providing coverage on both coasts and the Saint Lawrence Seaway;

- An integration of the 15 VTS centres and 29 Coast Guard Radio Station to reduce the network to a total of 22 sites; and

- Potentially an Automatic Identification system (AIS) for vessel traffic management.

Highlights of Current SN&C Work

In Canada, developments are well underway for the establishment of a comprehensive infrastructure of marine satellite navigation systems. Initial operational capability has been declared for Stage 1 of the economy's DGPS system which is 11 of the 18 permanent differential reference stations. It is anticipated that Stage 2 will be completed in early 1997.

Differential GPS without a chart display is of limited value in marine navigation, and in this respect, the Canadian Hydrographic Service (CHS) embarked on an extensive electronic chart pilot project. The objectives of this project included: demonstration of the ECDIS technology as an aid in grounding and collision avoidance; obtaining practical experience of ECDIS under a variety of operating conditions; the testing and evaluation of various proposed performance and data standards; and preparation of the CHS to provide services to the electronic chart community.

The CHS have moved towards producing all Canadian charts in digital format. As a result of the pilot project mentioned above, over 450 charts have been produced in digital format with most Canadian southern waters scheduled for completion within the next two years. It is anticipated that when the digitizing programme is completed, all Canadian charts will fully meet the international standards for digital format and content.

Canada is actively investigating the implementation of AIS. For example, AIS units were installed on board ships as part of a pilot project on the St. Lawrence River. The objective of this project was to verify the accuracy, dependability and reliability of this new technology. It is expected that the joint government/industry projects required for "proof of concept" of the AIS as a candidate for next-generation vessel traffic management technology capable of lowering overall traffic system costs will be completed in 1996.

Canada's marine industry has been a key player in SN&C implementation. They have actively participated in a number of trial projects for DGPS, ECDIS and AIS. The Canadian Shippers Association is also estimating that all of their members' fleet will be equipped with DGPS and ECDIS by the end of 1997.

SN&C Implementation Plans

Canada will continue with its adoption and use of SN&C technologies. In particular activities include:

- Completing implementation of DGPS in 1997.
- Continuing production of CHS charts in digital format
- Continue work on the development and implementation of ECDIS.
- Continue investigation of AIS as a candidate for vessel traffic management.
- Promote Canadian expertise in marine technologies and management internationally by fulfilling several international commitments to Taiwan, the U.S., Haiti, Surinam, Hong Kong, the Middle East, Indonesia, Korea, Mexico, Chile and the Caribbean.

Level of SN&C Implementation (High, Medium, Low)

Canada has a high level of SN&C implementation. The economy has implemented an extensive DGPS system and to support these stations will establish five manned control and monitoring stations. Canada is also actively investigating the implementation of an AIS. The economy has conducted significant trials on the use of DGPS/ECDIS involving 47 different chips on both east and west coasts, the Great Lakes and the St Lawrence River. The CHS has digitized a significant number of charts to international standards.

Issues Identified

Canada identified the following issues regarding the transition to SN&C:

- Extensive training required for mariners but there is a lack of training courses, capacity and resources.
- Difficulties in developing accepted international standards, both operational and technical, in a timely manner.

- Infrastructure demands for satellite navigation systems, development and distribution of electronic charts, and AIS require planning, implementation and management.

- Lack of chart availability and accuracy, and the resulting requirement to resurvey many areas of the world.

- Economic forces on mariner are creating a dichotomy between implementing technologies and infrastructure that meet all operational and technical requirements and those that are low cost and easily implemented.

- Regulations are not keeping up with technology.

- Possible implementation and reliance on sub-standard equipment.

- Implementation of VTS technologies (e.g. AIS) that are not interoperable.

Potential Actions Identified

Canada identified the following actions to reduce or eliminate transition issues:

- APEC

    - Assist with the provision of technical and financial assistance where required.

    - Sponsor/assist with the development of training standards and equipment, provision and pooling of training resources; and encourage training to international standards.

    - Encourage the development and sharing of infrastructure plans among the economies, users and international organizations.

    - Endorse international standards for electronic charts, support sharing of geodetic and hydrographic information, and encourage increased funding of hydrographic offices for the purpose of conversion to ENC.

    - Encourage and support cooperation and coordination among national regulations and standards setting bodies.

- Encourage the use of approved equipment and back-up equipment on all vessels.

- Support international VTS cooperation and database sharing.

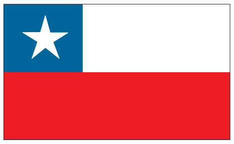
Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/ca.html" was used as well as data from the Statistics Canada web site, "www.statcan.ca".

- The following documentation on the Canadian aviation sector has been collected:
  - CNS/ATM Transition and Implementation Plan, January 1995
  - ANS Canada Book, January 1996
  - Time lines from the North American CNS/ATM Transition Plan, March 1996
  - Aviation Aggregate Demand Indicators, April 1996, TP 9589E
  - Results of the Study's Expert Panel on SN&C Implementation

- The following documentation on the Canadian marine sector was collected:
  - Canadian Coast Guard Web Site "http://lyra.newforce.ca"
  - "DGPS/ECDIS Developments in Canada - An Overview" prepared by D. Jenkins
  - Results of the Study's Expert Panel on SN&C Implementation
  - Response to SN&C Project Request for suggestions on possible APEC actions



Chile


Chile


Arica
Antofagasta
Valparaiso
Concepcion
Puerto Mo
Punta Arenas

Chile

General Description

Chile is located in South America between Argentina and Peru. The economy borders both the South Atlantic and the South Pacific Oceans. The land area is 748 800 square kilometres with a coastline 6 435 km long. The economy has a fertile central valley with low coastal mountains in the west and the rugged Andes Mountains in the east. The total population as of July 1995 was 14.2 million.

Chile's transportation infrastructure consists of: 7 766 km of railroads; 79 599 km of highways of which only 10 984 are paved; and 725 km of inland waterways which are of limited importance to transportation. There are 11 primary ports which are located at Antofagasta, Arica, Chanarol, Coquimbo, Iquique, Puerto Montt, Punta Arenas, San Antonio, San Vicente, Talcahuano and Valparaiso. Chile has 390 airports of which 298 have paved runways.

Trade

Chile has a prosperous, essentially free market economy. Recently, emphasis on social spending has increased with an estimated one million Chileans breaking free from poverty in the last four years. Copper remains vital to the health of the economy; Chile is the world's largest producer and exporter of copper. Rich in natural resources; the primary export commodities are copper, other metals and minerals, wood products, fish and fishmeal, and fruits. Exports were valued at U.S.$ 11.5 billion in 1994 with Chile's primary export partners being the European Community, Japan, the United States, Argentina and Brazil. The economy imported goods valued at U.S.$ 10.9 billion (1994) from the European Community, the United States, Brazil and Japan. Import commodities included capital goods, spare parts, raw materials, petroleum and foodstuffs.

Aviation SN&C Implementation

General Description

The Civil Aviation Authority of Chile is responsible for providing air navigation services in the economy's airspace. The airspace is divided into five FIRs covering both domestic and oceanic airspace, and eleven terminal areas. The traffic is controlled and monitored from five Area Control Centres, twenty-five towers (six international airports and nineteen domestic airports) and twenty Flight Service Stations.

Traffic

Total aircraft movements for 1995 were approximately 400 000 with Chile handling 182 676 domestic landings, 15 934 international landings and 2 547 overflights. Annual domestic landings are expected to increase by 10 percent in 1996 and international landings by 5 percent.

Present & Future Infrastructure

Chile's air navigation system currently relies primarily on conventional ground-based systems. In the next five years, the economy will invest in communications, radio aids and radar to ensure 100% coverage of its airspace. Chile is using satellite voice communications for some en route traffic. The current systems also include ground communication links, HF voice, VHF voice, NDB, VOR/DME, primary and secondary radar and ILS. Chile is actively working towards implementing a full SN&C system. Plans include the implementation of SATCOM, VHF and HF data link, DGNSS en route and LAAS in terminal areas, ADS and ATM automation. Table 1 summarizes the current and future infrastructure of Chile's air navigation system.

Highlights of Current SN&C Work

Current SN&C work is focussed on planning for the implementation of SN&C technologies. In particular, Chile is working towards implementing initial operational capability of VHF data link and ADS by the year 2000 for en route traffic.

SN&C Implementation Plans

Schedules indicate that transition to DGNSS for en route traffic and LAAS for terminal areas will be completed by 2005. As there are no plans for Chile to implement an augmentation system, it is likely that the economy will connect to a regional system in South America. VHF data link will be available en route starting in 2000 with a full system including satellite communications and HF data link, implemented by 2005. ADS will be implemented from

2000 to 2005 for en route traffic and from 2005 to 2010 for terminal areas. ATM automation is scheduled in 2005 and 2010 for en route and terminal areas, respectively.

Level of SN&C Implementation (High, Medium, Low)

Chile has a medium level of SN&C implementation. Planning for the transition to these technologies is well underway and transition has begun with the availability of satellite communications. Chile will have implemented a full SN&C system by the year 2010.

Issues Identified

Potential issues that may impact implementation of SN&C technologies in Chile are:

- User acceptance;
- Institutional and legal factors;
- Limitations of current infrastructure;
- Need for education (in particular the lack of available information and training);
- Availability of funding; and
- Shortage of air traffic controllers.

Potential Actions Identified

Chile indicated that possible roles for APEC in fostering implementation of SN&C in their economy were providing funding assistance, technical assistance and planning assistance.

Marine SN&C Implementation

At the present time Chile has commissioned a LUT and is operating an MCC for the COSPAS SARSAT search and rescue activities within Chile and the region.

Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/ci.html" was used.

- The following documentation on the Chilean aviation sector has been collected:
  - Response to Framework Questionnaire and Survey.

Table 1: Current and Future ANS Infrastructure

Conventional Equipment/ Capability	Airspace where the Equipment/ Capability is Currently Used: Route	Terminal/ Approach Control	Airport/ Aerodrome Control
Ground Comm Links	○	●	●
HF voice	●/○	●/○	●/○
VHF voice	○	●	●
Omega			
NDB	●/○	●/○	
VOR	●/○	●/○	●/○
DME	●/○	●/○	
Primary Radar	●/○	●/○	
SSR Mode A/C	●/○	●/○	
ILS			●/○
MLS			
VASIS/PAPIS			●/○
SAT COMM - AFTN ORAL ATS			●

CNS/ATM Equipment/ Capability	Airspace where the Equipment/ Capability is Currently Used: Route	Terminal/ Approach Control	Airport/ Aerodrome Control
Satellite Communications	○		
VHF Data Link	○	○	○
HF Data Link	○		
SSR Mode S Data Link			
SSR Mode S Surveillance			
DGNSS	○		
LAAS		○	
RAS/MSAT			
ADS	○	○	
ATM Automation	○	○	
Other (Please Specify)			

Source: Economy's Response to Questionnaire

● Current Infrastructure ○ Future Infrastructure ●/○ Both Current & Future Infrastructure

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China


China


Qiqian
Hailar
Tsitsihar
Harbin
Jilin
Altai
Grumchi
Barkol
Kuga
Yumen
Jiuquan
Huhehot
Chengteb
Shenyang
Peking
Shache
Qiemo
Yinchwan
Taiyuan
Yutian
Xining
Lanchou
Tsingtao
Xi'an
Gortok
Qamdo
Chengtu
Wuhan
Shanghai
Xigaze
Chungking
Changsha
Foochow
Kunming
Canton
Victoria
Haikou

China

General Description

China is located in eastern Asia bordering the East China Sea, Korea Bay, Yellow Sea, and South China Sea between North Korea and Vietnam. China is the third-largest country (after Russia and Canada) with a land area of approximately 9.3 million square kilometres and a coastline 14 500 km long. The terrain in the west is mostly mountainous with high plateaus and deserts with plains, deltas, and hills in the east. The total population as of July 1995 was 1.2 billion.

Given the size of the country and the population, China's transportation infrastructure is significant. The economy has over 1 million km of highways although only 170 000 km are paved. The railway system is important to transportation in China with 65 780 km of tracks, 7 000 km of which is electrified and over 11 000 km of which is double track. The economy also has an extensive inland waterway system of 138 600 km of which 79% is navigable. There are 18 primary ports which are located in Aihui, Changsha, Dalian, Fuzhou, Guangzhou, Hangzhou, Harbin, Huangpu, Nanning, Ningbo, Qingdao, Qinhuangdao, Shanghai, Shantou, Tanggu, Xiamen, Xingang and Zhanjiang. For its land size, China has a relatively small network of airports totalling 204, all but 13 have paved runways.

Trade

Beginning in the late 1970's, China has been moving the economy from the sluggish Soviet-style centrally planned economy to a more productive and flexible economy with market elements (still within the framework of government control). The result has been a strong surge in both agriculture and industry production. In 1994, the strong growth continued in the widening market-oriented areas of the economy. The economy exported goods valued at U.S.$ 121 billion (1994); export commodities include textiles, garments, footwear, toys, machinery and equipment, and weapon systems. China's main export partners are Hong Kong, Japan, the United States, Germany, South Korea and Russia. Import commodities included rolled steel, motor vehicles, textile machinery, oil products and aircraft. China's main import partners are Japan, Taiwan, the United States, Hong Kong, Germany and South Korea. Imports obtained from these economies in 1994 had a value of $U.S. 115.7 billion.

Aviation SN&C Implementation

General Description

A significant change in China is shifting the management of air space from the military to the civil sector. The Beijing-to-Hong Kong route has already made that transition. The Civil Aviation Administration of China (CAAC) is responsible for airspace not under control of the military.

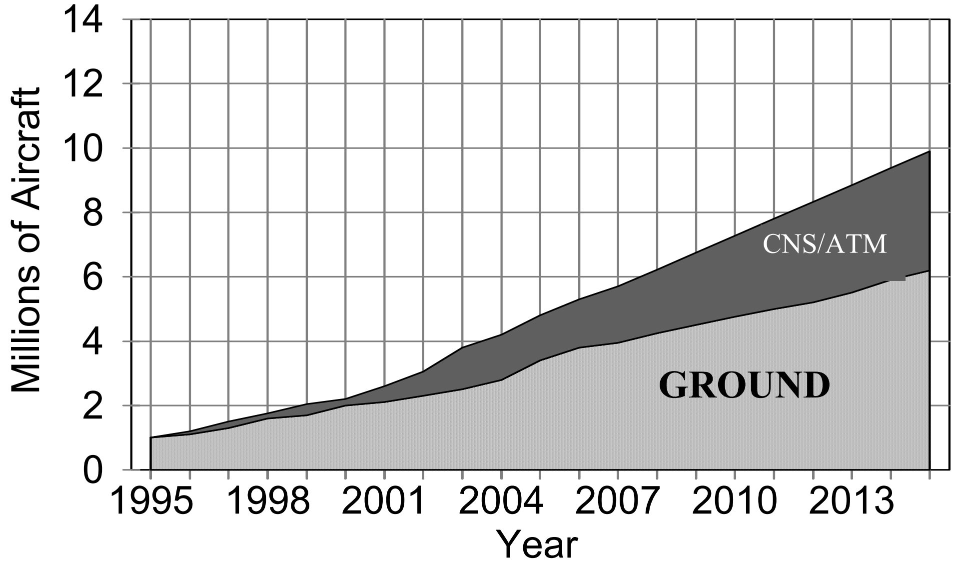
Traffic

Projections on air traffic growth are heavily dependent on the vibrancy of the Chinese economy. Also current travel restrictions on mainland China for both domestic and international travel have constrained growth. Nevertheless, according to estimates prepared by a Booz, Allen & Hamilton Inc. study, arrivals and departures will at least triple over the next 10 years and possibly increase by a factor of 4.5. In a decade, growth will be even greater, but with a larger disparity between the most optimistic and pessimistic projections.

The trade and traffic portion of this APEC study found that total international scheduled passenger traffic to and from China will increase 7.6 times between 1993 and 2010 reaching 62.3 million by the year 2010. The most significant growth will take place to and from Southeast Asia and to and from the Americas. Northeast Asia will remain by far the most important world region for traffic to and from China, but the relative importance of this region will diminish as China-Southeast Asia travel markets expand. Hong Kong will remain the most important economy of origin-destination for China. Japan and Thailand will become the second and third most important countries respectively, in the year 2010.

The Booz, Allen Hamilton study forecasted movements at the Xianyang Airport and determined that a ground-based air traffic control system would constrain China's ability to meet the projected air demand (See Figure 1-1).

Figure 1-1
Total Arrival and Departure Forecasts
Xian, China



Highlights of Current SN&C Work

The CAAC has integrated SN&C technologies into its northern region facility at Beijing in a pilot program with Boeing, United FANS-1 B747-400, an Air China GPS-equipped 737 and a Raytheon workstation. SITA and ARINC data networks link the Chinese and other ATM systems. Initial ADS trials in the spring were followed by ADS/radar integration in June. An updated system is slated for flight trials this fall. China also contracted a major study to analyse the benefits of satellite-based ATM compared with ground-based systems for the CAA and Chinese air carriers.

SN&C Implementation Plans

Current schedules, based on the Asia/Pacific Regional Plan for the New CNS/ATM Systems, indicate that transition to GNSS for en route traffic and terminal areas will both be operational by 1998 and for non-precision approaches in 1997. Data link will be available en route starting in 1997. Implementation of ADS will also begin in 1997 with the first operational CNS/ATM air route along the Beijing-Harbin-Russia border.

Level of SN&C Implementation (High, Medium, Low)

China has a high level of SN&C implementation. Economic analysis of SN&C technologies has been conducted. Planning for the transition to these technologies is progressing and significant operational trials are being undertaken on various aspects of SN&C technologies. Based on the current implementation plans, China will have initial operations of all elements of the SN&C technologies by 1998.

Issues Identified

No issues regarding SN&C implementation have been identified.

Potential Actions Identified

No potential APEC actions for resolving SN&C implementation issues have been identified.

Marine SN&C Implementation

General Description

The Maritime Safety Administration (MSA) of the Ministry of Communications in China is responsible for the implementation and management navigation aids in Chinese coastal waters.

Traffic

No traffic data was available.

Highlights of Current SN&C Work

The MSA has begun implementation of a Radio Beacon/Differential Global Navigation Satellite System (RB/DGPS). As of April 1996, five test stations were operational in the following locations: Tianjin, Qing Huangdao, Dalian, Shanghai and Hainan. The test operations have achieved good results to date.

SN&C Implementation Plans

A complete system of RB/DGPS will be implemented to provide high precision navigation and plotting in Chinese ports and coastal waters. The whole system of beacons will cover the Chinese ports and related water areas of Bohai Gulf, Qingdao, Shanghai and Qiongzhou straits. It is expected that the system will provide formally the high precision navigation service for Chinese and foreign users in these areas as of 1997. The implementation work is to be completed in stages.

Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/ch.html" was used.

- The following documentation on the Chinese aviation sector has been collected:
  - Trade, Traffic and APEC Report, APEC SN&C Study
  - "Demo Bolsters China's Credibility in ATM", Aviation Week & Space Technology, April 15 1996
  - "Asia/Pacific Leads FANS-1 Progress", Aviation Week & Space Technology, August 12 1996
  - Asia/Pacific Regional Plan for the New CNS/ATM Systems, Issue 4, Amendment No. 1, March 1 1996

- The following documentation on the Chinese marine sector has been collected:
  - "The Development of Radio Beacon / Differential Global Navigation Satellite System (RB/DGPS) in China" presented at the APEC Transport Working Group, 9th Meeting, Vancouver, Canada.

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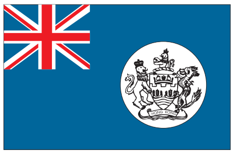
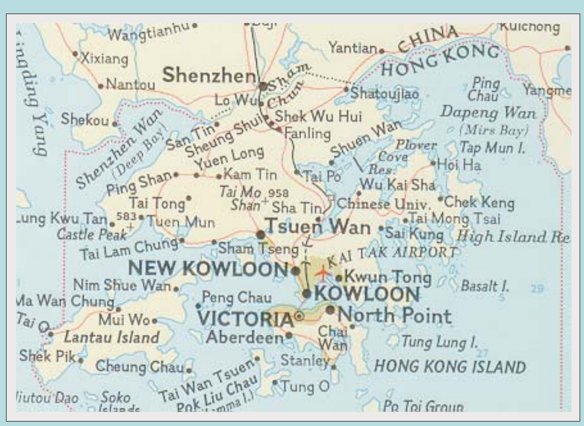


Hong Kong


Hong Kong


Wangtianhu
Xixiang
Nantou
Shenzhen
Yantian
CHINA
HONG KONG
Kuichong
Shekou
Lo Wu
Sham Chun
Shatoujiao
Ping Chau
Yangme
Dapeng Wan
(Mirs Bay)
Shek Wu Hui
Fanling
San Tin
Sheung Shui
Shenzhen Wan
(Deep Bay)
Yuen Long
Shuen Wan
Plover Cove Res.
Tap Mun I.
Hoi Ha
Ping Shan
Kam Tin
Tai Po
Wu Kai Sha
Tai Mo Shan
958
Sha Tin
Chinese Univ.
Chek Keng
Tai Tong
Lung Kwu Tan
583
Tuen Mun
Castle Peak
Tsuen Wan
Tai Mong Tsai
Sai Kung
High Island Re
Tai Lam Chung
Sham Tseng
KAI TAK AIRPORT
NEW KOWLOON
Kwun Tong
Nim Shue Wan
KOWLOON
Basalt I.
Ma Wan Chung
Peng Chau
Tai O
Mui Wo
VICTORIA
North Point
Lantau Island
Aberdeen
Chai Wan
Tung Lung I.
Shek Pik
Cheung Chau
Stanley
HONG KONG ISLAND
Tai Wan Tsuen
Pok Liu Chau
Tung O
Soko Islands
Po Toi Group

Hong Kong

General Description

Hong Kong is currently a dependent territory of the United Kingdom but will return to China on 1 July 1997. The economy is located in eastern Asia bordering the South China Sea and China and consists of some 236 islands and a small portion of the mainland adjoining Guangdong Province of China. The land area is approximately 990 square kilometres with a coastline of 733 km in length. The terrain is mostly hilly to mountainous with steep slopes and lowlands in the north. The total population as of July 1995 was 5.5 million.

Hong Kong does not require a large infrastructure to support its transportation requirements. There are 35 km of railroad; 1 100 km of highways of which 72 percent is paved; and no inland waterway system. There is one international port in Hong Kong and three airports all of which have paved runways.

Trade

Hong Kong has a bustling free market economy with few tariffs or non-tariff barriers. Natural resources are limited, and food and raw materials must be imported. In particular, imports include foodstuffs, transport equipment, raw materials, semi-manufacturers and petroleum. Imports for 1993 were valued at U.S.$ 160 billion however a large portion, over 75 percent, was re-exported. The economy's major import partners are China, Japan, Taiwan and the United States. Export commodities include clothing, textiles, yarn and fabric, footwear, electrical appliances, watches and clocks, and toys and were valued at U.S.$ 168.7 billion in 1994. Hong Kong's primary export partners were China, the United States, Germany, Japan and the United Kingdom. Tables 1 to 4 provide a summary of import and export data by trading partner for 1990, 1994 and 1995.

Table 1: Domestic Exports (f.o.b.) HK$ billion

Trade Partner	1990 (+**0.8**)	1994 (**-0.4**)	1995 (+**4.3**)
China	47.5	61.0	63.6
U.S.	66.4	61.4	61.2
Singapore	7.8	12.2	12.2
Germany	18.0	12.8	12.2
Japan	12.1	10.5	11.9
Asia-Pacific Economic Corporation	158.7	171.2	177.0
European Union	50.4	37.4	40.1
Total	225.9	222.1	231.7

Source: http://www.info.gov.hk...tat/hkinf/ex-trade.htm

Table 2: Re-Exports (f.o.b.) HK$ billion

Trade Partner	1990 (+**19.5**)	1994 (+**15.1**)	1995 (+**17.4**)
China	110.9	322.8	384.0
U.S.	87.8	210.1	231.0
Japan	24.4	54.7	70.1
Germany	23.4	41.6	45.8
United Kingdom	12.1	27.3	32.3
Asia-Pacific Economic Corporation	303.8	714.7	838.2
European Union	68.3	139.7	160.7
Total	414.0	947.9	1 112.5

Source: http://www.info.gov.hk...tat/hkinf/ex-trade.htm

Table 3:

HK$ billion	1990	1994	1995
Total Exports (Domestic and Re-Exports)	639.9	1 170.0	1 344.1

Source: http://www.info.gov.hk...tat/hkinf/ex-trade.htm

Table 4: Imports (c.i.f.) HK$ billion

Trade Partner	1990 (+**14.2**)	1994 (+**16.6**)	1995 (+**19.2**)
China	236.1	470.9	539.5
Japan	103.4	195.0	221.3
Taiwan	58.1	107.3	129.3
U.S.	51.8	89.3	115.1
Singapore	26.1	62.0	78.0
Asia-Pacific Economic Corporation	537.8	1 055.6	1 255.0
European Union	66.7	128.9	160.4
Total	642.5	1 250.7	1 491.1

Source: http://www.info.gov.hk...tat/hkinf/ex-trade.htm

Aviation SN&C Implementation

General Description

The Hong Kong Civil Aviation Department (CAD) is responsible for the provision of air traffic services (ATS) and Search and Rescue (SAR). The airspace consists of one Flight Information Region (FIR) with a single Terminal Area.

Traffic

In Asia-Pacific, the strongest growth was experienced by traffic between Hong Kong and Northeast Asia, essentially Taiwan and China. In particular, the relaxation of travel restriction imposed on Taiwanese residents in the mid-1980s has resulted in a large increase in Taiwanese visitors to Hong Kong. Hong Kong has played an active role in channelling traffic between Taiwan and China, since direct services do not exist between these two countries. The opening of direct links between Taiwan and China is expected to have some adverse effects on traffic between Hong Kong and Taiwan, but it is also expected that this would largely be offset by the emergence of a large Chinese outgoing travel market, which as yet is still in its infancy.

Total passenger traffic for 1990, 1994 and 1995 was 14.8 million, 19.9 million and 21.4 million respectively. A total growth of 45% from 1990 to 1995 or an average annual rate of 9%. Total international passenger traffic to and from Hong Kong is forecast to increase at an average annual rate of 7.8% between 1993 and 2000, decreasing slightly to 5.8% per annum between 2000 and 2010. The most rapid growth is expected to take place between Hong Kong and the Southwest Pacific as well as the Americas. By 2000, the most important country of origin-destination will be China, and it is expected that the predominance of China will be even more significant in 2010.

Present & Future Infrastructure

Current communications, navigation and surveillance (CNS) systems are ground-based facilities such as VOR, NDB, ILS, VHF and HF. Hong Kong plans to implement a full SN&C system. In particular, the economy plans to provide satellite communications, VHF and Mode S data link, Mode S Surveillance and ADS in the near future. Further downstream, Hong Kong will implement GNSS for en route, terminal and non-precision approaches (and possibly precision approaches). It is anticipated that the SN&C technology will first be applied in the en route phase. Plans for application in the approach and landing phase include possible curved approach paths. A summary of the current and future infrastructure is presented in Table 5.

Highlights of Current SN&C Work

The feasibility of applying satellite-based technologies (ADS and data communications in particular) in CNS is currently being studied by CAD engineers. Operational trials for ADS FANS-1 were scheduled to commence in August of 1996. A trial evaluation system similar to the one in use by New Zealand was to be installed at the Hong Kong International Airport.

Table 1: Current and Future ANS Infrastructure

Conventional Equipment/ Capability	Airspace where the Equipment/ Capability is Currently Used: Route	Terminal/ Approach Control	Airport/ Aerodrome Control	CNS/ATM Equipment/ Capability	Airspace where the Equipment/ Capability is Currently Used: Route	Terminal/ Approach Control	Airport/ Aerodrome Control
Ground Comm Links	●	●	●	Satellite Communications	○	○	○
HF voice	●	●	●	VHF Data Link	○	○	○
VHF voice	●	●	●	HF Data Link			
Omega				SSR Mode S Data Link	○	○	○
NDB	●	●		SSR Mode S Surveillance	○	○	○
VOR	●	●	●	DGNSS			
DME	●	●		LAAS			
Primary Radar	●	●	●	RAS/MSAT			
SSR Mode A/C	●	●	●	ADS	○		
ILS		●	●	ATM Automation	○		
MLS				Other (Please Specify)			
VASIS/PAPIS		●	●				
Other: PAR			●				

Source: Economy's response to Questionnaire

● Current Infrastructure ○ Future Infrastructure ●/○ Both Current & Future Infrastructure

1 For Marine SAR.
2 Slowly withdrawn by 2000.
3 Slowly withdrawn by 2003.
4 Implemented by 2001.
5 Implemented by early 1997.

SN&C Implementation Plans

Based on the information contained in the Asia/Pacific Regional Implementation Plan for the New CNS/ATN Systems, Issue 4, Amendment 1, Hong Kong will have initial operations for the following SN&C technologies:

- ATIS Data Link - 1997
- Air-Ground Data Link - 1998
- GNSS En route - 1998
- GNSS Terminal - 1998
- GNSS Non-Precision - 1998
- ADS - 1997
- Mode S - 1998

Level of SN&C Implementation (High, Medium, Low)

Hong Kong has a medium to high level of implementation of SN&C technologies. Planning for transition is well underway in the economy. Operational trails of ADS are just beginning in economy and the CAA is currently investigating GNSS and its applications. Based on the current implementation plans, Hong Kong will have initial operations of all elements of the SN&C technologies by 1998.

Issues Identified

Hong Kong identified the following issues regarding transition to SN&C: high capital cost may make some of the SN&C technologies difficult to justify; level of user demand; and competitive advantage.

Potential Actions Identified

Hong Kong indicated that APEC could play a role in:

- Dissemination and provision of technical data.
- Assistance with coordination of implementation plans.
- Assistance with funding and sharing of costs among economies.

Marine SN&C Implementation

General Description

Hong Kong is strategically located, both in relation to China and the neighbouring Asian countries. It lies at the mouth of the Pearl River Delta and is at the centre of the Asia-Pacific rim, a region where the economy is growing at a phenomenal pace. Being the junction of two different forms of maritime transport -- the large ocean-going vessels from the Pacific Ocean and the smaller, coastal and river trade craft from the Pearl River -- and the only modern, fully developed deep water harbour between Singapore and Shanghai, Hong Kong is the focal point of all maritime trading activities in Southern China. In 1995 Hong Kong handled 163 million tonnes of cargo through its port and 12.5 million TEUs, making it the busiest container port in the world.

The Marine Department is responsible for the day to day administration of the Hong Kong Port, all navigational matters in Hong Kong and the safety standards of all classes and types of vessels. In particular, Port Services handles port operations, navigational safety, marine emergencies, buoys and navigational aids, pollution control, search and rescue coordination and passenger terminals. Vessel Traffic Services provides services to ocean-going vessels visiting Hong Kong to ensure their safety and to facilitate their arrival.

Traffic

As one of the busiest ports in the world, Hong Kong has seen significant in growth in vessel arrivals, container throughput and cargo throughput. Between 1992 and 1995, arrivals increased by 44%, container throughput by 57%, and cargo throughput by 52%. About 41 000 ocean-going vessels entered the economy in 1995. On an average day there are more than 200 ocean-going ships working in the port; 1 200 ocean-going and river trade craft enter or leave the port; and about 10 000 craft working and/or passing through the harbour. Table 6 presents port statistics for the years 1992 to 1995.

Table 6: Port Statistics by Year Since 1992

Year	International Vessel Arrivals			Container Throughput (TEUs)	Cargo Throughput	
	Ocean-Going	River Trade			Ocean-Going	River Trade
		International Ferry	Trading Vessel			
1992	28 255	52 999	67 907	7 971 758	83 382	19 333
1993	33 042	55 837	76 775	9 204 236	96 100	22 038
1994	36 997	63 183	92 048	11 050 030	110 947	30 079
1995	41 043	64 477	109 428	12 528 692	127 175	28 732

Source: http://www.info.gov.hk/mardep/portstat/porstat.htm

Forecast demand of Hong Kong's port is such that capacity needs to be expanded to cope with up to 1.5 million additional TEUs each year for the foreseeable future. On the basis of the Marine Departments forecasts, the port will have to handle 267 million tonnes of cargo by the year 2006. By 2011, demand will have risen to 349 million tonnes. In terms of container growth, the port can be expected to handle 25.5 million TEUs in 2006 and 32 million in 2011. The great majority of this cargo will be sourced from or destined for southern China.

Present & Future Infrastructure

The Marine Department of Hong Kong is also hoping that technology and efficiency will enable it to maintain pre-eminence as rival ports are built in China. The current navigational infrastructure consists of 350 navigation aids of which 96 are light buoys and the rest are light beacons and a number of lighthouses. The Hong Kong Vessel Traffic Centre (VTC) came into operation in October 1989. With eight shore-based radars and a computerized radar surveillance system, the VTC can virtually visualize the marine traffic situation in over 95% of Hong Kong's waters. Ships are identified with the aid of a VHF Direction Finding system on their first voice contact and their names tagged with the corresponding targets on the radar surveillance system.

The Hong Kong Maritime Rescue Coordination Centre is responsible for coordinating all maritime search and rescue (SAR) operations with the Hong Kong SAR Region which covers the South China Sea from mainland China south to 10 degrees north and east to 120 degrees. The Centre is well equipped and has a full range of sophisticated marine radio and advanced distress monitoring equipment.

A differential GPS Central Reference Station has been set up on Kau Yi Chau to broadcast GPS differential corrections in RTCM SC-104 format using MSK modulation in 289.0 KHz with position accuracy of better than one metre within Hong Kong territorial waters. The Hong Kong Hydrographic Office, responsible for all hydrographic surveys and charting services, has also begun the process of preparing charts in digital format.

Highlights of Current SN&C Work

Highlights of current SN&C work by Hong Kong in the marine sector include:

- Implementation of a DGPS Central Reference Station.
- Re-surveying and conversion of charts to WGS84; production of charts in digital format (as well as hard copy).

SN&C Implementation Plans

No information on future plans for SN&C technology implementation was available.

Level of SN&C Implementation (High, Medium, Low)

Based on the information available, Hong Kong has a medium to high level of implementation of SN&C technologies. The economy has implemented a DAPS reference station and has begun converting their charts to digital format. However, no information was available on future plans for DAPS or AIS.

Issues Identified

No issues regarding SN&C implementation have been identified.

Potential Actions Identified

No potential APEC actions for resolving SN&C implementation issues have been identified.

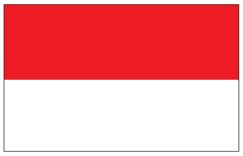
Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/hk.html" and the Hong Kong government web site "http://www.infor.gov.hk" were used.

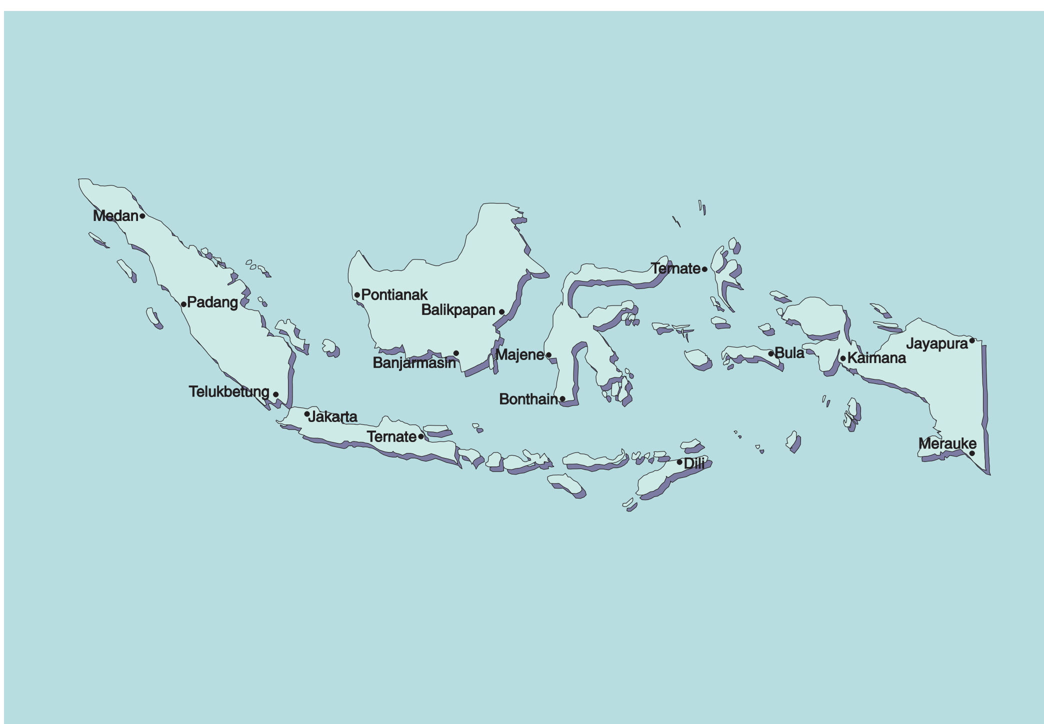
- The following documentation on the Hong Kong aviation sector has been collected:
  - Trade, Traffic and APEC Report, SN&C Study, September 1996.
  - Interview Notes to Framework Questionnaire.
  - Asia/Pacific Regional Plan for the New CNS/ATM Systems, Issue 4, Amendment No.1.
  - CAE News Release, "CAE Awarded Contract for Satellite-based Air Traffic Control System for Hong Kong", Toronto, February 1996.

- The following documentation on the Hong Kong marine sector was collected:
  - Hong Kong Marine Department Web Site "http://www.info.gov.hk/mardep".
  - Trade, Traffic and APEC Report, SN&C Study.



Indonesia

Indonesia



Medan
Padang
Pontianak
Balikpapan
Ternate
Banjarmasin
Majene
Bula
Kaimana
Jayapura
Telukbetung
Bonthain
Jakarta
Ternate
Merauke
Dili

Indonesia

General Description

Indonesia is an archipelago of over 17 000 islands (of which 6 000 are inhabited) and is located northwest of Australia between the Indian Ocean and the Pacific Ocean. The total land area is approximately 1.83 million square kilometres with 54 716 km of coastline. The terrain is mostly coastal lowlands with the larger islands having interior mountains. The total population as of July 1995 was 203.6 million.

Being an archipelago, Indonesia relies extensively on its marine and aviation transportation infrastructure. There are eight primary ports which are located in Cilacap, Cirebon, Jakarta, Kupang, Palembang, Semarang, Surabaya and Ujungpandang and over 21 000 km of inland waterways. There is a total of 450 airports of which 414 have paved runways. There are also 119 500 km of highways and 6 964 km of railroads.

Trade

Indonesia is a mixed economy with some socialist institutions and central planning, however there is a continuing move towards deregulation and private enterprise. Indonesia has extensive natural wealth such as agriculture, including forestry and fishing, crude oil, natural gas, metals and coal. In 1994, total exports were valued at U.S.$ 41.3 billion with the primary export commodities being manufactures, fuels, foodstuffs, and raw materials. The economy's main export partners are Japan, the United States, Singapore, South Korea and Chinese Taipei. For the same year, the main import commodities were capital equipment, interned and raw materials, consumer goods, and fuels; the total value of these goods were $U.S. 31.4 billion. Indonesia's major import partners were Japan, the United States, South Korea, Germany, Singapore, Australia and Chinese Taipei.

Aviation SN&C Implementation

Description

The Director General of Air Communication (DGAC) within the Ministry of Communications is responsible for the air navigation system in Indonesia. Control services are administered within four Flight Information Regions (FIR) by the Medan, Jakarta, Bali and Ujung Pandang Air Traffic Service Centre (ATSC). There are also two Upper FIRs formed by a north-south boundary which creates an airspace division in the approximate centre of the country. Jakarta and Ujung Pandang ATSCs are the UIR control authorities in the western and eastern segments, respectively.

Traffic

A summary of forecast results, prepared in 1993, is presented in Table 1. Indonesia's domestic airport passenger demand (for those 70 airports reporting traffic data) is expected to more than triple over the next 20 years from 19.5 million passenger movements in 1991 to 93.2 million movements in the year 2013.

The future growth rate of international airport passenger movements is forecasted to exceed that of domestic passengers through the year 2003. Total international scheduled traffic to and from Indonesia is forecast to reach 11.4 million and 26.1 million passengers in 2000 and 2010 respectively. This represents an average annual growth rate of 9.4% between 1993 and 2000 and 8.7% between 2000 and 2010. Contributing the most to this significant traffic growth, to and from Indonesia, will be Northeast Asia and Southwest Pacific with Singapore remaining the most important country of origin and destination through 2010. By 2013, international passenger movements will increase 6.1 times over the 1991 level for a total of 28.4 million movements.

Aircraft movements are increasing each year, especially on the international routes. Air traffic volume in the Jakarta FIR was 204 017; an increase of 11%, with overflights increasing by 7%, from 1990 to 1991. The three other ACC's are experiencing similar growth.

Table 1: National Airport Traffic Demand Summary

Item	Year					Average Annual Growth Rate			
	1984	1991	1998	2003	2013	1984 - 1991	1991 - 1998	1998 - 2003	2003 - 2013
Airport Passengers (000)									
Domestic	13 539	19 468	31 057	43 744	93 157	5.3	6.9	7.1	7.9
International	2 312	4 644	8 951	13 376	28 387	10.5	9.8	8.4	7.8
Total	15 851	24 112	40 008	57 121	121 544	6.2	7.5	7.4	7.8
Air Cargo (Metric Tons)									
Domestic	117 100	221 071	336 824	474 618	1 005 859	9.5	6.2	7.1	7.8
International	46 000	119 025	237 988	351 064	785 601	14.5	10.4	8.1	8.4
Total	163 100	340 096	574 812	825 682	1 791 460	11.1	7.8	7.5	8.1
Mail (Metric Tons)									
Domestic	12 500	20 422	34 102	47 831	100 432	7.3	7.6	7.0	7.7
International	3 600	2 722	4 371	5 849	9 527	-3.9	7.0	6.0	5.0
Total	16 100	23 144	38 473	53 680	109 959	5.3	7.5	6.9	7.4
Annual Aircraft Movements									
Domestic	532 000	575 416	512 200	604 800	969 800	1.1	-1.6	3.4	4.8
International	23 000	42 165	61 179	88 467	168 004	9.0	5.5	7.7	6.6
Total	555 000	617 581	573 379	693 267	1 137 804	1.5	-1.1	3.9	5.1

Source: Executive Summary, Integrated Air Transport Study, December 1993.

Present & Future Infrastructure

Indonesia's air navigation system currently relies on conventional ground-based systems. The current systems include:

- Ten primary radars and eleven secondary radar facilities;
- 38 VOR/DMEs;

- 16 ILSs;
- 142 NDBs; and
- 40 VHF communications locations and 13 HF communication locations.

Indonesia will transition its equipment from the present ground-based system to SN&C technologies. Based on the "Integrated Air Transport Study" prepared in 1993, the economy plans to implement all components of CNS/ATM: satellite communications, VHF, Mode S and Satcom data links, ATN, GNSS for enroute, non-precision and CAT I precision approaches, and ATM automation.

Highlights of Current SN&C Work

Current work is focussing on the feasibility of the Palapa Satellite as a link of the AND in the Asia-Pacific Region. The objective of the study is to identify the capability of the Palapa Satellite in supporting the CNS/ATM implementation and to enhance harmonization and coordination among administrations in the region. The study is scheduled to begin by mid 1997 and to last one year. It is believed that implementation of an aeronautical mission payload on board the Palapa Satellite could improve satellite communication in the region and harmonization of CNS/ATM, provide wide area augmentation of GNSS in concert with MTSAT, and allow for the possible establishment of an "Integrated South East Asia" FIR.

SN&C Implementation Plans

SN&C implementation data was unavailable for Indonesia.

Level of SN&C Implementation (High, Medium, Low)

Given the information available, Indonesia was assessed to have a medium level of SN&C implementation. No SN&C technologies have been implemented to date but Indonesia has begun investigation into a regional satellite system. Indonesia is planning to implement a full CNS/ATM system but operational dates for the components are not available.

Issues Identified

No issues regarding SN&C implementation have been identified.

Potential Actions Identified

No potential APEC actions for resolving SN&C implementation issues have been identified.

Marine SN&C Implementation

No information has been supplied to date.

Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/id.html" was used.

- The following documentation on the Indonesian aviation sector has been collected:
  - Integrated Air Transport Study, December 1993.
  - Trade, Traffic and APEC Report, APEC SN&C Project.
  - Asia/Pacific Regional Plan for the New CNS/ATM Systems, Issue 4, Amendment No.1
  - "Study on Palapa Satellite for Sub Regional ATM" presented at the APEC Transport Working Group, 9th Meeting, Vancouver, Canada.
  - "ASEAN Countries Approach to the New CN/ATM" presented at the APEC Transport Working Group, 9th Meeting, Vancouver, Canada.

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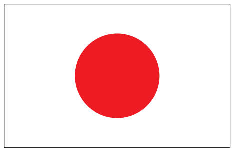
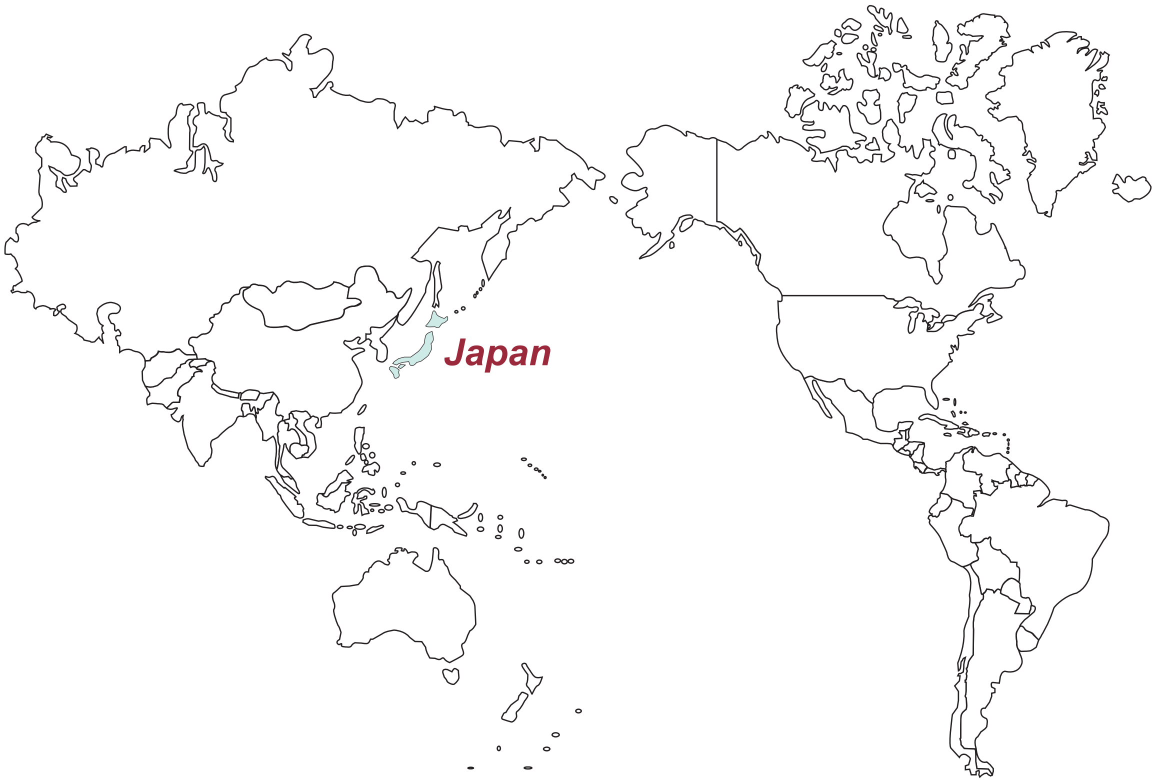
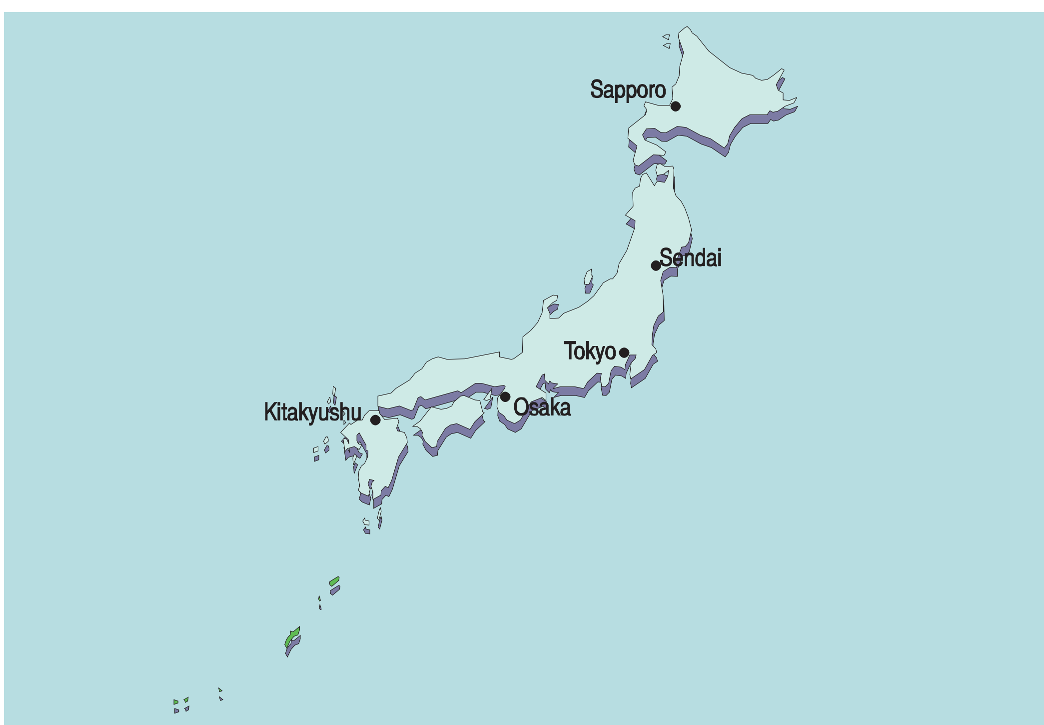


Japan





Japan

General Description

Japan is an island chain located between the North Pacific Ocean and the Sea of Japan, east of the Korean peninsula. The land area is approximately 374 thousand square kilometres with a coastline 29 751 km long. The terrain is mostly rugged and mountainous. The total population as of July 1995 was 125.5 million.

Japan has developed a very significant transportation infrastructure. There are over 1 million km of highways of which 75% is paved; 27 327 km of railroad with over 40% electrified; and about 1,770 km of inland waterways. The economy has eight primary ports located at Chiba, Kitakyushu, Kobe, Nagoya, Osaka, Shimizu, Tokyo and Yakohama. There is a total of 175 airports in the economy, only two of which do not have paved runways.

Trade

Government-industry cooperation, a strong work ethic, mastery of high technology, and a comparatively small defence allocation have helped Japan become one of the most economically successful economies in the world. Industry, the most important sector of the economy, is heavily dependent of imported raw materials and fuels. The primary import commodities in 1994 were manufactures, fossil fuels, foodstuffs and raw materiels. These imports were valued at U.S.$ 274.3 billion. Exports were valued at U.S.$395.5 billion and consisted mainly of manufactures including machinery, motor vehicles and consumer electronics. Japan's major trade partners are Southeast Asia, the United States, Western Europe and China.

Aviation SN&C Implementation

General Description

The Civil Aviation Bureau of the Ministry of Transport is responsible for air navigation services in Japan.

Traffic

Between 1985 and 1993 nearly 35 million passengers passed through Japan, in and out, at an average annual rate of 9.8% per annum with a growing share of this traffic being handled at regional airports (Japanese cities other than Tokyo and Osaka are generating an increasing share of total departing seats out of Japan.). Expected passenger traffic will grow to nearly 91 million by 2010. Total international scheduled passenger traffic to and from Japan is forecasted to grow by 6.1% per annum between 1993 and 2000, decreasing slightly to 5.5% per annum between 2000 and 2010. The U.S. mainland will remain the most important origin and destination country for Japan with almost 14 million passengers by 2010, followed distantly by Korea. Traffic between Japan and the Americas is also forecasted to achieve relatively strong rates of growth with the opening of new routes between Japan and Latin America.

In sharp contrast to many of the other countries in the Asia-Pacific region, forecast rates of growth for Japan's international passenger traffic are generally *lower* than for other countries in the region. The reasons for this are attributed to the fact that Japan is a mature market with a well established air traffic industry, while many emerging countries, such as Vietnam, are only beginning to realize their potential for air transport.

Present & Future Infrastructure

Details were not available on Japan's current communication, navigation and surveillance infrastructure. Japan is committed to implement SN&C technologies. In particular, the economy plans to implement the Multi-functional Transport Satellite (MTSAT) to support data link, ADS and wide area augmentation for GNSS for all phases of flight. The economy also has plans to implement Mode S radar.

Highlights of Current SN&C Work

Current SN&C work is focussing on the implementation of the MTSAT. This satellite is expected to be the heart of Japan's SN&C system. MTSAT has both a meterological mission and an aeronautical mission:

- Meterological mission includes:
  - Weather observation
  - Weather information acquisition and dissemination

- Aeronautical mission includes:
  - ADS
  - Data link
  - GPS overlay/integrity channel for GPS wide area augmentation

Japan is working closely with the United States to ensure compatibility between the U.S. Wide Area Augmentation System (WAAS) and MTSAT, to exchange technical data, and to continue cooperation in promoting the modernization of air navigation systems in the Asia-Pacific Region.

SN&C Implementation Plans

Based on schedules presented in the Asia/Pacific Regional Plan for the New CNS/ATM Systems, GNSS for en route traffic, terminal area, and non-precision approaches will be available in 2001. Data link and ADS will also be available starting in 1997. The current plans are to have Mode S installed in 1998. The MTSAT will be launched in 1999 at which time the wide area augmentation capability (the MTSAT Augmentation System (MSAS)), will become available.

Level of SN&C Implementation (High, Medium, Low)

Based on the available information, Japan was assessed to have a high level of SN&C implementation. Trials and demonstrations on the various components of SN&C have been underway for a over three years. The economy has plans to implement a full CNS/ATM system by the year 1999 with capabilities such as ADS, data link and GNSS available in 2001.

Issues Identified

No issues regarding SN&C implementation have been identified.

Potential Actions Identified

No potential APEC actions for resolving SN&C implementation issues have been identified.

Marine SN&C Implementation

General Description

The Maritime Safety Agency (MSA) has been carrying out various safety missions: guard and rescue missions including maintenance traffic safety and prevention of marine pollution; hydrographic services; and aids to navigation. In order to carry out these missions efficiently, MSA employs communication stations, patrol vessels, aircraft and various communication systems. Specifically, there are:

- Ten District Communications Centres;
- Nine MS Office Communications Stations; and
- Four Port Control Communications Stations.

The MSA communications stations provide:

- Communications relating to maritime casualties;
- Broadcast of Maritime Safety Information;
- Communications relating to Ship Position Reports;
- Traffic control communications; and
- Port Operation Communications.

Traffic

Oceangoing shipping represents 99.8% of the total Japanese trade, with freight moving in and out of Japan accounting for as much as 20% of the world total sea cargo movement. A summary for selected ports of shipping tonnage is presented in Table 1 and for ship arrivals in Table 2.

Table 1: Summary of Shipping Tonnage for Selected Ports

Port	Average Ship Size	Max. Ship Draught	Unit	Shipping Tonnage (In 1000) 1989	1990	1991	1992	1993
Chiba	1 518	----	grt	121 782	128 567	128 378	132 384	125 295
Kitakyushu	1 172	----	grt	82 042	84 889	89 903	88 084	89 964
Kobe	3 552	----	grt	270 586	288 352	302 510	296 806	----
Nagoya	4 414	13	grt	173 047	189 411	197 198	200 309	203 595
Osaka	1 924	----	grt	117 492	119 211	122 660	130 631	----
Shimizu	4 788	12	grt	38 942	42 750	44 238	48 379	46 685
Tokyo	2 321	----	grt	117 983	125 508	131 909	133 462	116 557
Yakohama	4 760	----	grt	230 027	235 022	233 218	245 354	265 082

Source: Shipping Statistics Yearbook, 1994 Institute for Shipping Economics and Logistics (ISL) Breman, Germany.

Table 2: Summary of Ship Arrivals for Selected Ports

Port	Number of Ship Arrivals 1989	1990	1991	1992	1993	Average
Chiba	86 184	88 732	88 601	87 103	52 545	86 633
Kitakyushu	82 012	80 973	81 882	79 667	76 769	80 261
Kobe	89 628	92 639	91 676	83 551	----	89 374
Nagoya	50 088	50 395	48 817	46 682	46 121	48 421
Osaka	76 422	73 883	70 690	67 906	----	72 225
Shimizu	9 816	10 296	10 517	10 164	9 751	10 109
Tokyo	57 659	55 934	56 753	54 387	50 213	54 989
Yakohama	62 016	61 736	58 831	56 390	55 691	58 933

Source: Shipping Statistics Yearbook, 1994 Institute for Shipping Economics and Logistics (ISL) Breman, Germany.

Present & Future Infrastructure

Japan's MSA utilizes an extensive communications network for providing the services offered by its organization. This network consists of:

- Shore-based direction finding stations.

- Coastal stations monitoring international distress frequencies, transmitting safety messages, weather forecasts and warnings as sea, notifications and instructions to large vessels, using Inmarsat, MF and HF radios, digital select calling (DSC), and NAVTEX (automated direct printing broadcast service).

- Mission Control Centre (MCC) and Local User Terminal (LUT) for COSPAS-SARSAT.

- AFTN and Telex for communication with foreign countries such as Korea and Russia.

- Global Maritime Distress and Safety System (GMDSS).

- Japanese Ship Reporting System (JASREP) which is a voluntary system.

No information was available of the current infrastructure of the navigation aids or on the plans for the future infrastructure.

Highlights of Current SN&C Work

No information was available on current SN&C work.

SN&C Implementation Plans

No information was available on SN&C implementation plans.

Level of SN&C Implementation (High, Medium, Low)

Due to the unavailability of information it is not possible to determine the level of SN&C implementation in the marine sector for the Japan.

Issues Identified

No issues regarding SN&C implementation have been identified.

Potential Actions Identified

No potential APEC actions for resolving SN&C implementation issues have been identified.

Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/ja.html" was used.

- The following documentation on the Japanese aviation sector has been collected:
  - MOT web site, "http://www.motnet.go.jp"
  - Trade, Traffic and APEC Report, APEC SN&C Project
  - "We Transport the Future" prepared by the MOT
  - Multi-Functional Transport Satellite Brochure
  - Multi-Functional Transport Satellite Paper
  - Asia/Pacific Regional Plan for the New CNS/ATM Systems, Issue 4, Amendment No.1

- The following documentation on the Japanese marine sector was collected:
  - MOT web site, "http://www.motnet.go.jp"
  - Trade, Traffic and APEC Report, APEC SN&C Project
  - "We Transport the Future" prepared by the MOT
  - Maritime Safety Agency Documentation

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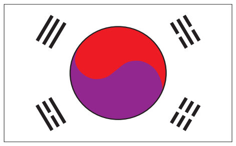

Republic of Korea

Republic of Korea

General Description

The Republic of Korea lies south of North Korea in eastern Asia on the southern half of the Korean peninsula bordering the Sea of Japan and the Yellow Sea. The land area is approximately 98.2 thousand square kilometres with a coastline 2 413 km long. The terrain is mostly hills and mountains with wide coastal plains in the west and south. The total population as of July 1995 was 45.6 million.

Korea has developed a transportation infrastructure that consists of: 6 763 km of railroad; 63 200 km of highways; and 1 609 km of inland waterways that are primarily restricted to small native craft. There are nine primary ports located at Chinhae, Inch'on, Kunsan, Masan, Mokp'o, Pohang, Pusan, Ulasn and Yosu. The economy has 114 airports of which 110 have paved runways.

Trade

The driving force behind Korea's dynamic growth has been the planned development of an export-oriented economy in a vigorously entrepreneurial society. In 1994 exports were valued at U.S.$96.2 billion and the primary commodities were electronic and electrical equipment, machinery, steel, automobiles, ships, textiles, clothing, footwear and fish. Imports were valued at U.S.$102.3 billion and the primary commodities were machinery, electronics and electronic equipment, oil, steel, transport equipment, textiles, organic chemicals and grains. Korea's main trade partners are the United States, Japan and the European Union.

Aviation SN&C Implementation

General Description

The Civil Aviation Bureau of the Ministry of Construction and Transportation is responsible for the air navigation system (ANS) in Korea which has a total airspace area of 562 504 sq. km. The CAB oversee ANS services at fourteen airports, and provides air traffic control from one Area Control Centre, five towers, two Approach Control Offices and one Flight Services Station.

Traffic

By the year 2010, passenger traffic will grow to 42.8 million passengers. This reflects a significant increase from just over 11 million passengers in 1993. In terms of percentage increase, total international scheduled passenger traffic to and from Korea will increase at an average annual rate of 8.8% between 1993 and 2000 and 7.7% between 2000 and 2010. Europe will continue to achieve the strongest growth of all world regions to and from Korea, with an average annual rate of 17.4% and 11.1% for 1993 to 2000 and 2000 to 2010 periods respectively. The second highest growth rate will be sustained by traffic to and from Southeast Asia. Japan will remain the most important country of origin-destination for Korea with total passenger traffic between the two countries reaching nearly 12 million passengers by 2010.

Present & Future Infrastructure

Korea's air navigation system is presently based on conventional, ground-based aids. The current systems include ground communication links, VHF (both voice and data link), NDBs, VOR/DMEs, primary and secondary radars, and ILSs. Korea is actively working towards transitioning a full SN&C system. Plans include the implementation of satellite communications, DGNSS for en route, terminal and non-precision/precision approaches, ADS and Mode S. Table 1 summarizes the current and future infrastructure of Korea's air navigation system.

Highlights of Current SN&C Work

South Korea is actively pursuing the benefits of SN&C technologies despite having only established an Advisory Committee within the CAB in 1992. The committee is composed of experts working for academies, research institutes and airlines. The economy has prepared an initial implementation plan and will actively participate in the implementation process in line with regional planning in the Asia/Pacific region. The economy has conducted VHF data link trials that indicate a practical service will be operational in the Taegu FIR by the late 1990s, and satellite communications for ADS will start shortly thereafter. A ground earth station for AMSS and ADS was constructed by Korea Telecom in late 1995 and aeronautical satellite communication services began in February 1996.

Table 1: Current and Future ANS Infrastructure

Conventional Equipment/ Capability	Airspace where the Equipment/ Capability is Currently Used: Route	Terminal/ Approach Control	Airport/ Aerodrome Control	CNS/ATM Equipment/ Capability	Airspace where the Equipment/ Capability is Currently Used: Route	Terminal/ Approach Control	Airport/ Aerodrome Control
Ground Comm Links	●/○	●/○	●/○	Satellite Communications	○		
HF voice				VHF Data Link	○	○	●/○
VHF voice	●/○	●/○	●/○	HF Data Link			
Omega				SSR Mode S Data Link		○	
NDB		●	●/○	SSR Mode S Surveillance	○	○	○
VOR	●/○	●/○	●/○	DGNSS	○	○	○
DME	●/○	●/○		LAAS			○
Primary Radar	●/○	●/○		RAS/MSAT			
SSR Mode A/C	●/○	●/○		ADS	○		
ILS			●/○	ATM Automation	○	○	
MLS				Other (Please Specify)			
VASIS/PAPIS			●/○				
Other Please Specify							

Source: Economy's Response to Questionnaire & APANPIRG Regional CNS/ATM Plan, Issue 4, Amendment 1

● Current Infrastructure ○ Future Infrastructure ●/○ Both Current & Future Infrastructure

SN&C Implementation Plans

The economy will develop detailed plans between 1998 and 1999 for the transition from the current systems to the new CNS/ATM System. Schedules presented in the Asia/Pacific Regional Plan for the New CNS/ATM Systems (Issue 4, Amendment 1) indicate the Korea will have initial operation of its SN&C components by the year 2000. Trials for both ATIS and ADS are scheduled to begin in late 1997. Currently, operational use of satellite data link for air-ground communications in 1998, GNSS is scheduled for 1999, ADS for 1999, and Mode S for 2000.

Level of SN&C Implementation (High, Medium, Low)

Based on the available information, the Republic of Korea has a medium to high level of SN&C implementation. The economy has progressed far in a short time having only begun focussing efforts on SN&C implementation in 1992. Operational trails are underway however no components have been implemented to date. The economy does plan to implement a full CNS/ATM system which will be operational by the year 2000.

Issues Identified

The Republic of Korea is going to move forward with establishing CNS/ATM with national financing; however, the economy is having difficulties in securing the necessary funding. In the future, Korea is expecting to use an Investment Fund supported through improvements in a collecting system for Air Navigation facilities charges. It is hoped that the charging collecting system relating to ICAO CNS/ATM be set up as soon as possible so as to help promote related CNS/ATM implementation project with every economy.

Potential Actions Identified

The economy did not identify any potential actions that APEC could undertake to resolve issues regarding SN&C implementation.

Marine SN&C Implementation

No information has been supplied to date.

Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/ks.html" was used.

- The following documentation on the Korean aviation sector has been collected:
  - Response to Framework Questionnaire and Survey.
  - Korea's CNS/ATM Implementation Plan
  - "Future Systems Relieve Congested Asian Routes", Jane's Airport Review, November 1995.
  - Asia/Pacific Regional Plan for the New CNS/ATM Systems, Issue 4, Amendment 1.
  - Trade, Traffic and APEC Report, APEC SN&C Study, September 1996.

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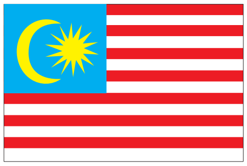

Malaysia

Malaysia

General Description

Malaysia lies south of Thailand in Southeastern Asia and its land includes a peninsular area and the northern one-third of the island of Borneo bordering the Strait of Malacca, the Java Sea and the South China Sea. The land area is approximately 328.6 thousand square kilometres with a total coastline length of 4 675 km (Peninsular Malaysia 2 068 km, East Malaysia 2 607). The terrain is coastal plains rising to hills and mountains. The total population as of July 1995 was 19.7 million.

Malaysia has developed a transportation infrastructure consisting of: 1 801 km of railroads; 29 028 km of highways; and 3 209 km of inland waterways. There are 9 international ports and 115 airports of which 107 have paved runways.

Trade

The Malaysian economy, a mixture of private enterprise and a soundly managed public sector, has posted a remarkable record of 9% average annual growth in 1988-94. Manufacturing as a share of the GDP increased on average by 13% per year between 1993 and 1995 and manufactured good exports expanded rapidly. In 1994, exports were valued at U.S.$ 56.6 billion with the main export commodities being electronic equipment, petroleum and petroleum products, palm oil, wood and wood products, rubber and textiles. Malaysia's major export partners are Singapore, the United States, Japan, the United Kingdom, Germany and Thailand while the major import partners were Japan, the United States, Singapore, Taiwan, Germany, the United Kingdom and South Korea. Import commodities included machinery and equipment, chemicals, food and petroleum products and were valued at U.S.$ 55.2 billion in 1994. Table 1 provides a summary of external trade.

Table 1: Summary of External Trade (RM$ millions)

External Trade	1993		1994		1995	
	RM$	% Growth	RM$	% Growth	RM$	% Growth
Total Export	121 214	16.9	148 011	22.1	179 760	21.4
Rubber	2 132	-9.6	2 295	7.7	2 244	-2.2
Crude Petroleum	7 996	-12.3	6 210	-22.3	6 292	1.3
Tin	489	-32.2	485	-6.3	490	7.0
Palm Oil	5 772	6.7	7 800	35.1	7 205	-7.6
Sawlogs & Sawn timber	7 459	1.6	7 102	-4.8	7 400	4.2
Manufactures	89 666	26.1	114 773	28.0	143 466	25.0
Total Imports (c.i.f)	117 432	15.8	147 900	26.0	178 959	21.0

Source: http://www.jaring.my/msia/economy/econtabl.html

Aviation SN&C Implementation

General Description

No information was available that provided a general description of the Department of Civil Aviation, the Malaysian airspace structure and the air navigation services provided.

Traffic

Traffic for most world regions to and from Malaysia has recently achieved double-digit growth with only two exceptions, to and from South Asia and Southeast Asia. The main world traffic region for Malaysia was Southeast Asia with 60.5% of total international traffic in 1993. This share has decreased since 1985, when it represented 71% of total international traffic. Total international scheduled passenger traffic in and out of Malaysia will increase at an average annual rate of 7.0% and 6.7% during the 1993 to 2000, and 2000 to 2010 time periods respectively. By the year 2010, this traffic will amount to 24.6 million passengers.

Future regions of growth will point to the Americas followed by Northeast Asia. The recent development of direct services between Malaysia and Latin America on the one hand, and China on the other hand, will contribute significantly to this trend. The most important country of origin and destination was Singapore, with 43% of total international passenger traffic in 1993. This shows a relative decline from 56% in 1985. Also, as traffic expands on many routes to and from Malaysia, the share of Singapore-Malaysia is expected to decline even further to just 26.6% by 2010.

Present & Future Infrastructure

No information was available on the present and future air navigation infrastructure for Malaysia.

Highlights of Current SN&C Work

No information was available on the current SN&C work being undertaken in the aviation sector by Malaysia.

SN&C Implementation Plans

Based on schedules contained in the Asia/Pacific Regional Plan for the New CNS/ATM Systems, Issue 4, Amendment 1, Malaysia will have initial operations of the following components of SN&C technologies in the identified year:

- Air-Ground Data Link - 1997

- ADS - 1999

Level of SN&C Implementation (High, Medium, Low)

Due to the unavailability of information, it was not possible to determine the level of implementation of SN&C technologies.

Issues Identified

No information was available on issues regarding implementation of SN&C technologies in Malaysia.

Potential Actions Identified

No information was available on potential actions that APEC could undertake to assist with SN&C implementation in the Asia-Pacific Region.

Marine SN&C Implementation

General Description

The Ministry of Transport is responsible for marine transportation in Malaysia. The ministry oversees fourteen domestic ports and nine international ports. Marine emergency services are provided from 4 Emergency Response Centres.

Traffic

Malaysia's three big ports – Penang, Port Klang and Johor – are building hard to double capacity from the current level of 1.2 million TEUs. The most ambitious development is taking place at Port Klang, near the Malaysian capital, Kuala Lumpur, where the Malaysians are planning to invest U.S.$593 million. The port authority predicts that the amount of cargo going through Port Klang will double by 2000 and has suggested that Malaysia's expansion is aimed at Singapore.

Malaysian intra-Asia container throughput volume for the years 1986 - 1993 was 402, 462, 589, 740, 888, 1 074, 1 113, 1 350 in thousand of TEUs, respectively. Estimated intra-Asia containerized cargo movements for Malaysia are presented in Table 2.

Table 2: Estimated Intra-Asia Containerized Cargo Movements (TEUs)

Destination Origin	Taiwan	Hong Kong	South Korea	Singapore	Philippines	Thailand	Indonesia	Total
Malaysia	34 500	35 700	9 500	33 400	4 000	7 000	10 000	134 100

Source: Compiled on the basis of data supplied by Kaiun (Shipping), various issues, 1993.

Present & Future Infrastructure

Malaysia's current marine communication, navigation and surveillance infrastructure includes: HF, VHF and satellite communications (Inmarsat), DGPS, radar, and COSPAR-SARSAT. Future plans include the DGPS service and coastal surveillance radar for the Malacca Strait, NATEX service and VHF data link (VHF DSC). Table 3 summarizes the current and future infrastructure of Malaysia's marine system.

Table 3: Current and Future Marine System Infrastructure

Conventional Equipment/ Capability	Marine Area where the Equipment/ Capability is Currently Used: Route	Port Control Zone	Coastal/ Inland Waterway	SN&C Equipment/ Capability	Marine Area where the Equipment/ Capability is Currently Used: Route	Port Control Zone	Coastal/ Inland Waterway
Surface Comm Links	●/○	●/○	●/○	Satellite Communications	●/○		
HF Voice	●/○		●/○	VHF Data Link (DSC)[2]	○		○
VHF Voice	●/○	●/○	●/○	HF Data Link (DSC)			
Omega				NAVTEX[3]	○		○
NDB (RDF)				SSR Mode S Surveillance			
Radar[1]	○	●/○		DGPS[4]	●/○		●/○
Loran-C				GMDSS			
SARTs				RAS/MSAT			
EPIRBs				INMASAT	●/○		
Radar Transponders				COSPAR-SARSAT	●/○	●/○	●/○
PNS/ECDIS				Other Please Specify			
ECS							
Other							

Source: Economy's Response to Questionnaire

● Current Infrastructure ○ Future Infrastructure ●/○ Both Current & Future Infrastructure

1 Radar implemented in 1997

2 VHF Data Link - 1998

3 NAVTEX - 1996

4 DGPS Implementation Completed - 1998

Highlights of Current SN&C Work

The economy has begun implementation of DGPS.

SN&C Implementation Plans

Future plans include the implementation of the following SN&C technologies:

- NAVTEX implemented - 1996
- DGPS implementation completed - 1998
- VHF data link completed - 1998

Level of SN&C Implementation (High, Medium, Low)

Based on the available information, Malaysia has a medium level of SN&C implementation. The establishment of DGPS is underway in this economy and will be completed in 1998. Malaysia also has plans to supplement its current infrastructure with VHF data link and NAVTEX. However, it is unclear as to what work is being undertaken in the areas of electronic navigation charts for Malaysian waters and ECDIS.

Issues Identified

No information was available on issues regarding implementation of SN&C technologies in Malaysia.

Potential Actions Identified

No information was available on potential actions that APEC could undertake to assist with SN&C implementation in the Asia-Pacific Region.

Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/my.html" and the web site "http://www.jaring.my/msia/economy/econotabl.html were used.

- The following documentation on the Malaysian aviation sector has been collected:
  - Asia/Pacific Regional Plan for the New CNS/ATM Systems, Issue 4, Amendment 1, 1/3/96.
  - Trade, Traffic and APEC Report, APEC SN&C Study, September 1996.

- The following documentation on the Malaysian marine sector has been collected:
  - Economy's response to questionnaire.
  - Trade, Traffic and APEC Report, APEC SN&C Study, September 1996.

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Mexico

Mexico

Tijuana
Ensenada
Hermosillo
Chihuahua
Monterrey
La Paz
Guadalajara
Veracruz
Mexico City
Cancun
Acapulco
Oaxaca
Tapachura

Mexico

General Description

Mexico is located in North America; bordering the Caribbean Sea and the Gulf of Mexico between Belize and the U.S., and bordering the North Pacific Ocean between Guatemala and the U.S. The land area is approximately 1.9 million square kilometres with a coastline 9 330 km long. The terrain is a mixture of high rugged mountains, low coastal plains, high plateaus and desert. The total population as of July 1995 was 94.0 million.

Mexico currently has a development program under way (Communication and Transportation Sector: 1995-2000 Development Program) to preserve, modernize and expand Mexico's transportation infrastructure to foster economic growth, regional integration and social development. The railway transportation system links 30 states through its 26 445 km network. The 303 265 km of road system link state capital, local governments, urban and rural areas, ports, borders and airports. 5 683 km of the national highways system are toll-road federal highways and 147 456 km are rural roads. Approximately 84 800 km of the highways are paved. The marine transportation system consists of 76 ocean ports and nine river ports. Thirty-one are commercial ports and fifty-four serve the fishing and tourism industry. There are also 2 900 km of navigable rivers and coastal canals. The air transportation infrastructure consists of 83 public airports, 51 of which serve both international and domestic flights.

Trade

Mexico's membership in the North American Free Trade Agreement (NAFTA) with the United States and Canada, its solid record and economic reforms, and its strong economic fundamentals bode well for the economy's economic outlook. In 1994, Mexico's exports were value at U.S.$ 60.8 billion including in-bond industries. In particular, export commodities include crude oil and oil products, coffee, silver, engines, motor vehicles, cotton and consumer electronics. Imports to Mexico were U.S.$ 79.4 billion with the primary commodities being metal-working machines, steel mill products, agricultural machinery, electrical equipment, car parts for assembly, repair parts for vehicles, aircraft and aircraft parts. The economy's main trading partners are the United States, Japan and the European Community.

Aviation SN&C Implementation

General Description

SENEAM is the public decentralized organization which is responsible for the providing the services for satellite, navigation and communication system in the aviation sector. The economy's airspace is divided into four FIRs covering both domestic and oceanic airspace, and 28 terminal areas. The traffic is controlled and monitored from four Area Control Centres, 56 towers (13 with precision approach aids, 43 with non-precision approach aids and the remaining six with no approach aids) and 33 Flight Service Stations.

Traffic

No traffic data was available.

Present & Future Infrastructure

Mexico's air navigation system currently relies primarily on conventional ground-based systems. The communication system is composed of the AFTN which handles the oral and written communications between the national ATS facilities as well as the operation of the remote air-ground communications stations by the ACCs and the transmission of radar data to the ACCs. The pilot controller communication is achieved on the VHF frequencies assigned to 27 remote air-ground communication stations and on the frequencies of the 56 control towers, 28 approach control facilities and 11 AFIS.

The current navigation system is comprised of VOR/DMEs, NDBs and ILSs. Of the 74 VOR/DMEs, 16 are used only for en route navigation and the remaining 58 serve en route navigation as well as to make the airport approach and climb procedures. 16 ILSs are installed at 13 airports.

The surveillance system is comprised of 18 secondary radars and eight primary radars. Of the 18 SSRs, ten are the only source of information for en route control and eight are co-located with primary radars for control in terminal areas. Two of these are monopulse.

Mexico is actively working towards implementing a full CNS/ATM system. Communication plans include the implementation of satellite data link and investigation of HF, VHF and Mode S data links to determine the most appropriate systems for the economy's airspace. Navigation requirements will be met by GNSS including wide area augmentation via the United States Wide Area Augmentation System and local area augmentation. Mexico also plans to implement ADS (based on ARINC 622 specification) in its oceanic airspace by 1999 and will transition to ADS via ATN at a later date. The establishment of the ATN will be made progressively. During this transition, it is expected that both voice VHF and HF will continue to be available. The number of remote air-ground communication stations will be increased from 27 to 40 by 1997. It is intended to extend, in the long term (2003-2015), the total number of ground stations up to 60 depending on the budgetary capabilities of SENEAM.

Highlights of Current SN&C Work

Mexico is currently developing a detailed regional implementation plan with Canada and the United States. The economy has also approved GPS for en route. No other information was available on current SN&C work being undertaken by Mexico.

SN&C Implementation Plans

Mexico's CNS/ATM implementation plans are:
- GNSS terminal and non-precision approach - 1998
- Satellite Data Link - 1999
- VHF A/G Data Link - Oceanic, 2003 and Domestic, 2006
- ADS (non-standard) - 1999; Standard - Oceanic, 2003 and Domestic, 2006
- Wide Area Augmentation System - 2000
- ATN- 2000
- ATM - Oceanic, 2003 and Domestic, 2006

Level of SN&C Implementation (High, Medium, Low)

Based on the information available, Mexico has a medium to high level of SN&C implementation. The economy is developing a detailed implementation plan and plans to implement a full CNS/ATM system with many components operational in 2000. However, Mexico has not yet implemented CNS/ATM systems as of 1996.

Issues Identified

No issues regarding SN&C implementation have been identified.

Potential Actions Identified

No potential APEC actions for resolving SN&C implementation issues have been identified.

Marine SN&C Implementation

General Description

No information was available.

Traffic

No traffic data was available.

Present & Future Infrastructure

Satellite communications are provided by Telecomunicaciones de México (TELECOMM). The company provides voice and data communication service for maritime applications (as well as land and air) using the MSAT technology on the "L" band of the solidarity satellite system.

Highlights of Current SN&C Work

No information was available on current SN&C work.

SN&C Implementation Plans

No information was available on the economy's SN&C implementation plans.

Level of SN&C Implementation (High, Medium, Low)

Based on the available information, it is not possible to assess the level of SN&C implementation for the marine sector in Mexico.

Issues Identified

No issues regarding SN&C implementation have been identified.

Potential Actions Identified

No potential APEC actions for resolving SN&C implementation issues have been identified.

Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/mx.html and the web site "www.iwm.com.mx/ser...T/prog952000/english.html" were used.

- The following documentation on the Mexican aviation sector has been collected:
  - Canada/Mexico/United States Regional CNS/ATM Implementation Plan.
  - Response to Framework Questionnaire and Survey.

- The following documentation on the Mexican marine sector was collected:
  - Movisat: Direction of Commercial Satellite Services, TELECOMM.

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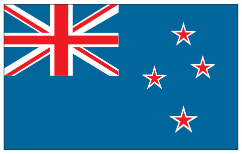


New Zealand


New Zealand


Auckland
Gisborne
New Plymouth
Wellington
Greymouth
Christchurch
Dunedin
Invercargill

New Zealand

General Description

New Zealand comprises North Island, South Island with Stewart Island at its southern tip and several outlying islands. The land area is approximately 268.7 thousand square kilometres with a coastline of 15 134 km long. The terrain is predominately mountainous with some large coastal plains. The total population as of July 1995 was 3.4 million.

New Zealand's transportation infrastructure consists of: 4 716 km of railroads; 92 648 km of highways; and 1 609 km of inland waterways which are of limited importance to transportation. There are five primary ports which are located at Auckland, Christchurch, Dunedin, Tauranga and Wellington. New Zealand has 79 airports with paved runways and 23 airports with unpaved runways.

Trade

Since 1984 the government has been reorienting an agrarian economy dependent of a guaranteed British market to a more industrialized, open free market economy that can compete on the global scene. Over the years, this economy has moved away from its dependence on dairy, meat and wool exports as forestry, horticulture, fishing and manufacturing have become more significant. Tourism is also an increasingly important sector of the economy.

New Zealand's small economy is heavily dependent on overseas trade. Table 1 presents a summary of export and import percentages by the main trading partners. Total exports in 1994 were valued at U.S.$ 11.2 billion with the primary commodities being agriculture (wool, lamb, mutton, beef, fish, fruits and vegetables), chemicals, forestry products and manufactures. Imports (at U.S.$ 10.2 billion) are primarily manufactured goods such as machinery and equipment, vehicles and aircraft, and consumer good as well as petroleum. New Zealand's primary trading partners are Australia, the United States, Japan and the United Kingdom.

As Table 1 shows, it can be seen that exports from New Zealand to the Asia-Pacific Region (Australia, Asia, Japan, China/Taiwan and Oceania) between 1984 and 1994 increased by 8.5 percent from 48.1 percent to 59.9 percent with the largest increase for Australia. On the other hand, imports from these same countries decreased slightly from 55.1 percent to 52.2 percent in the same time period. Table 2 summarizes overseas cargo unloaded and loaded at New Zealand ports between 1992 and 1994.

Table 1: Summary of Exports/Imports by Main Trading Partners

Main Trading Partners	% of Exports		% of Imports	
	1994[1]	1984	1994	1984
Australia	20.9	15.0	21.5	20.4
Asia	15.3	9.8	8.3	10.7
Japan	14.6	15.4	15.8	20.8
U.S.	11.3	13.0	18.1	15.0
Other EC	9.5	9.8	12.0	11.3
UK	6.0	10.3	6.1	8.8
China/Taiwan	5.2	3.9	5.9	1.9
Oceania	3.9	4.0	0.7	1.3
Eastern Europe	1.1	3.3	0.1	0.4

Note: 1) Year ended 30 June.
Source: http://www.govt.nz/ps/...economy.html#Transport

Table 2: Summary of Overseas Shipping Cargo (gross tonnes 000)

Overseas Cargo	1992	1993	1994
Total			
Unloaded	8 346	9 000	10 408
Loaded	15 857	16 500	17 028
North Island Ports			
Unloaded	6 747	7 386	8 626
Loaded	11 994	12 538	12 859
South Island Ports			
Unloaded	1 544	1 549	1 702
Loaded	3 784	3 879	4 076

Source: http://www.govt.nz/ps/...economy.html#Transport

Aviation SN&C Implementation

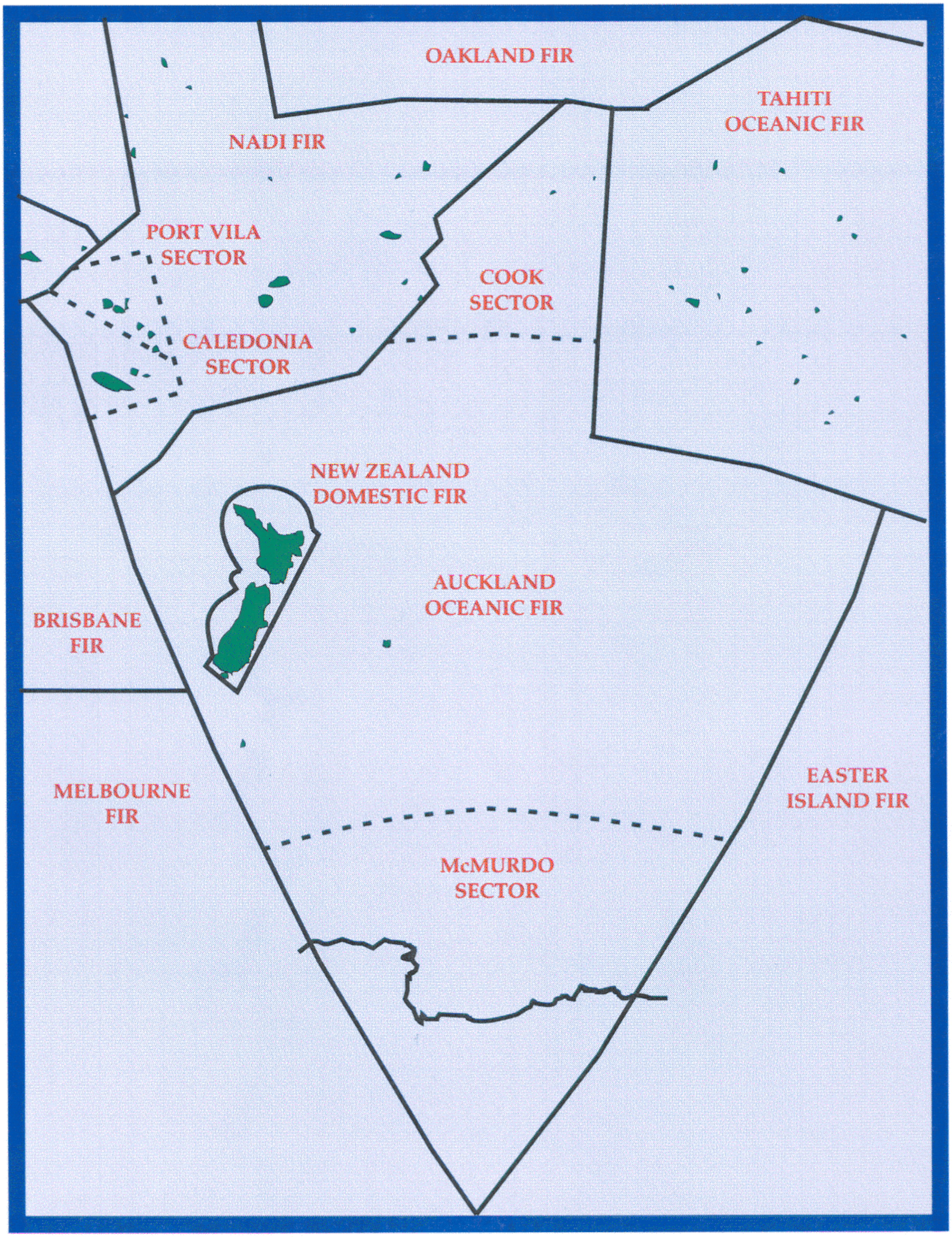
General Description

The Airways Corporation of New Zealand Limited (Airways) provides air traffic control, flight information, and navigation services to the aviation industry within two flight information regions, one for domestic airspace and one for oceanic airspace (See Figure 1). The total controlled airspace is 34 million square kilometres, with the two FIRs and 12 terminal areas. The airspace is controlled from three ACCs and 19 towers, and supplemented with services from two FSSs. There are three international airports and 94 domestic airports.

Traffic

Domestic disposable incomes and savings based on New Zealand Institute of Economic Research and the National Bank of New Zealand forecasts are projected to be 6% in 1995/96 with GDP growth in the range of 3-4% per annum in the period 1996-1998. For the purpose of forecasting traffic GDP growth was assumed to be 3% per annum in the period 1999-2010.

Figure 1: Designated Airspace



In 1994, the total annual domestic landings were 611 118 and international landings were 11 392. There were also 3 079 international overflights in 1994. The traffic demand is projected to significantly increase during the planning period. The number of aircraft movements at international and large domestic airports are projected to grow at a rate of 3.0 - 4.9 % per annum, with smaller airports growing at a more modest rate of 1.0 - 1.2 % per annum. The main domestic routes are likely to experience aircraft movement growth rates of 2.1 - 2.5 % per annum, with oceanic traffic growing at 4.1 - 4.9 % per annum. Table 3 provides a summary of the forecast aircraft movements.

Present & Future Infrastructure

Table 4 presents a summary of the present and future systems for the oceanic and domestic airspaces. New Zealand has an extensive structure of the standard ground-based systems for communication, navigation and surveillance. The only notable system not implemented or planned to be implemented is MLS. As can be seen from Table 4, New Zealand is planning to implement a full CNS/ATM system using satellite-based systems such as GNSS, AMSS and ADS.

Highlights of Current SN&C Work

Airways has been playing a key role in the implementation of SN&C technology in the region. In recent years New Zealand has been actively involved in ICAO and other regional meetings to promote and agree on the procedures and schedules for the introduction of new systems. New Zealand committed to implement the FANS 1 system for oceanic control in 1993. An interim system was delivered by CAE Electronics in April of 1995 with a scheduled delivery date for the final system of September 1996. This is the first oceanic control system based on SN&C technology in the world.

This economy is also moving rapidly towards a full implementation of GNSS and its augmentation. Supplementary en route and non-precision approaches were introduced in 1995 with some sole means en route and non-precision approaches as well. New Zealand is expecting to be connected to the United States System, WAAS or via Australia which may connect to the United States system.

SN&C Implementation Plans

Table 5 presents the SN&C implementation plans developed by Airways in 1995. This table presents the plans for both the existing and planned systems.

Table 3: Summary of Airways Annual Movement Forecasts 1995 - 2009

	Average 1990 - 1994	Average 1995 - 1999	Average 2000 - 2004	Average 2005 - 2009
Movements				
International Airports [1]	370 000	449 000	557 000	681 000
Domestic (A) Airports [2]	419 000	559 000	693 000	820 000
Domestic (B) Airports [3]	375 000	387 000	409 000	431 000
Unattended Airports [4]	14 000	16 000	17 000	18 000
Domestic Main Trunk Routes [5]	213 000	240 000	268 000	296 000
Oceanic FIR [6]	25 000	30 000	37 000	45 000
All "Other" Domestic Routes [7]	317 000	356 000	376 000	396 000
TOTAL	**1 733 000**	**2 037 000**	**2 357 000**	**2 687 000**
Growth Rates				
International Airports [1]	1.7%	4.9%	4.1%	4.1%
Domestic (A) Airports [2]	3.2%	4.9%	4.1%	3.0%
Domestic (B) Airports [3]	-6.1%	1.2%	1.0%	1.0%
Unattended Airports [4]	-1.8%	1.2%	1.0%	1.0%
Domestic Main Trunk Routes [5]	1.7%	2.5%	2.1%	2.1%
Oceanic FIR [6]	1.2%	4.9%	4.1%	4.1%
All "Other" Domestic Routes [7]	-0.4%	1.2%	1.0%	1.0%

Notes:
1) Auckland, Wellington, Christchurch International Airports
2) All other Airports with >50 000 movements in 1993
(Ardmore, Hamilton, Nelson, Palmerston North, Queenstown)
3) All Airports with <50 ,000 movements in 1993
4) All unattended Airports (IFR movements only)
5) All IFR movements on Auckland-Wellington-Christchurch main trunk
6) All movements in the Auckland Oceanic FIR
7) All other movements in domestic airspace

Definitions:
1) An airport movement is one take off, landing or missed approach
2) A Domestic or Oceanic movement is one flight.

Source: Air Navigation Plan, Airways Corporation of New Zealand Ltd., 1995, pg. 15.

Table 4: Summary of Present and Future Systems

	Communication	Navigation	Surveillance	Air Traffic Management
Present Oceanic Systems (1995)	• HF Radio • AFTN (Data) • Voice between Oceanic Centres	• Inertial Navigation Systems • OMEGA/LORAN-C • Barometric Altitude	• Voice Position Reporting • Some Monopulse Secondary Radar	• Procedural with computer aided flight plan processing (Aircat 2000) • Paper flight strips • Manual conflict detection • Manual co-ordination between Oceanic Centres • Fixed Tracks • 100 mile, 2000 ft separation
Future Oceanic Systems (2010)	• Satellite Voice & Data using the Aeronautical Mobile Satellite Service • Automatic data co-ordination between Oceanic Centres via ATN data network	• Global Navigation Satellite System & Augmentation • Barometric Altitude	• Automatic Dependent Surveillance • Airborne Collision Avoidance Systems	• Aircraft Situation Displays • Computer aided conflict detection, probe • Automatic data co-ordination between Oceanic Centres • Flexible & Dynamic Routing • 30 mile, 1000 ft separation • Required Navigation Performance Procedures • Controller to pilot data link
Present Domestic Systems (1995)	• VHF Radio (Voice) • UHF Radio (Voice) • HF Radio • AFTN (message switching & aeronautical database) • ATIS (Voice) • National voice switching and data switching systems	• NDB • VOR • DME • ILS • Barometric Altitude	• Primary Radar • Monopulse Secondary Radar (Mode A/C) • Voice Reporting	• Computer aided flight plan processing (Aircat 2000) • Paper flight strips • Flight Data Displays • Radar Displays • Multi-radar tracking • Fixed Routes • Manual Conflict Detection
Future Domestic Systems (2010)	• VHF Radio (Voice) • VHF air-ground data link • HF Radio • Message Switching System • Aeronautical Database • ATN • National voice switching and data switching systems	• Global Navigation System & Augmentation • Barometric Altitude	• Automatic Dependent Surveillance • Possible Primary or Secondary Radar • Possible Airport Surface Detection Equipment	• Aircraft Situation Displays providing coverage over most of New Zealand • Computer aided short term conflict alert • Flight Data Displays • More flexible, direct & dynamic routing • Controller to pilot data link • Required Navigation Performance/ RNAV

Source: Air Navigation Plan, Airways Corporation of New Zealand Ltd., 1995, pgs. iv,vi.

Table 5: SN&C Implementation Plans

Element	Existing	Retired	Planned	Implemented
Communication	46 VHF Voice 7 HF Voice 7 UHF Voice AFTN	– 2005 (Oceanic) 1997 2001	VHF Data Link ACARS Satcom D/L AMSS Data Link (ATN) AMSS Voice ATN	2006 1995 1998 2000 1998
Navigation	34 NDB 16 NDB/DME 18 VOR/DME 6 ILS CAT I 1 ILS CAT II/III GNSS Suppl..	2000 2000 2005 - 2010 2001 2005 –	GNSS Stand Alone En route GNSS Stand Alone NPA GNSS NPA Conversion to WGS84 GNSS CAT I GNSS CAT II/III	1996 1996 2000 1997 1998 2004
Surveillance	4 PSR 6 SSR Mode A/C ADS FANS-1	2006+ 2006+ 2000	ADS CNS-1	2000
Separations Oceanic	100x80x2000' 50x50x2000' (RNP10)	 1996	30x30x2000'(RNP4) 10x10x1000' (RNP1) 5x5x1000'(RNP0.3)	1996 2000 2003
Separations Domestic			10x10 (RNP1) 5x5 (RNP0.3)	2000 2003

Source: Air Navigation Plan, Airways Corporation of New Zealand Ltd., 1995.

Level of SN&C Implementation (High, Medium, Low)

New Zealand is considered to have a high level of implementation. They have developed a comprehensive and detailed air navigation plan that maps the transition to an SN&C based system. They currently have an oceanic control system based on FANS-1 operational with plans to move to a full ATN based ADS by 2000. New Zealand is also moving quickly to adopt GNSS and its augmentation. GNSS has been approved for supplemental use and will soon be approved for stand alone use in special cases. Airways also plans to implement augmentation and if feasible adopt GNSS for Cat II/III approaches. Based on implementation plans, New Zealand currently has initial operations of all elements of the SN&C technologies except for wide area augmentation of GNSS; but the economy plans to connect to a regional system such as WAAS or MTSAT.

Issues Identified

New Zealand identified the following issues regarding transition to SN&C:

- Level of user acceptance and the time required for airlines and general aviation to adopt to new technology. Emphasis on equipment and procedures familiarity is required.

- The cost of implementing SN&C technologies may be an issue however its impact should diminish as system costs will gradually reduce on acceptance of new technology in place of conventional navigation aids.

- Institutional factors in the form of regulatory approvals of GPS procedure design criteria and pilot training endorsement were also identified as an impediment to SN&C implementation.

- ICAO is a consensus body and progress is inherently slow.

- A perception that a legal framework is necessary for implementation of SN&C.

Potential Actions Identified

New Zealand identified the following actions to reduce or eliminate transition issues:

- APEC

  - APEC should compliment rather than duplicate ICAO.

  - Encourage adoption of SN&C technologies within its region, supporting the implementation activities of ICAO, IATA, the regional sub-groups, the informal associations and the airlines.

  - Keep Ministers and senior policy makers aware of the economic benefits in undertaking implementation programs.

  - Bring funding matters to the attention of the people who make the infrastructure funding decisions within each economy.

- Monitor the progress towards implementation. For example, in three to five years the Congestion Point Study could be revisited.

- Encourage private sector involvement in implementation programs and to ensure that service providers in their economies are structured in a way which gives greater control of projects and can deliver benefits to their respective customers and users.

- Support regional co-operation in implementation activities.

- ICAO

  - Develop niche task forces focussed on specific issues and quicker acceptance by central body.

Marine SN&C Implementation

General Description

The New Zealand Maritime Safety Authority (MSA) lies under the Ministry of Transportation with the charter of enhancing efficiency in the delivery of safety and other services to the New Zealand maritime industry. The MSA aims to enhance the safety of seafarers and shipping and protect the marine environment from pollution.

Traffic

New Zealand has low traffic levels with only 2 000 to 3 000 ships calling on New Zealand ports annually.

Present & Future Infrastructure

New Zealand has implemented a vessel reporting scheme for international shipping and a voluntary code for tankers for environmental protection purposes only. Neither are mandatory; however, after an accident in late 1995, New Zealand is considering making the reporting scheme mandatory. There is no requirement for a traffic control scheme due to the low traffic levels. Primary communications for vessels inbound to New Zealand are handled by the Perth (Australia) receiving station using satellite communications.

Highlights of Current SN&C Work

Currently, the focus is on safety and dealing with vessels in distress; SAR being the primary tool.

SN&C Implementation Plans

New Zealand Ministry of Transportation has no SN&C implementation plans at this time.

Level of SN&C Implementation (High, Medium, Low)

The level of SN&C implementation in New Zealand is low. New Zealand has no requirements for DGPS, as the service is not viewed as cost-beneficial.

Issues Identified

No SN&C implementation issues were identified by the economy.

Potential Actions Identified

No APEC actions for resolving implementation issues were identified.

Data Sources

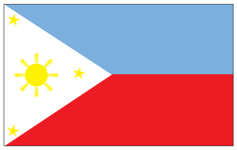
A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/as.html" and the government's web site "www.govt.nz.ps" were used.

- The following documentation on New Zealand aviation has been collected:
  - Completed Questionnaire
  - New Zealand Air Navigation Plan (1995 - 2010)
  - APEC Paper on "World's First Oceanic Control System"
  - Interview Notes to Framework Questionnaire

  - Response to SN&C Project Request for suggestions on possible APEC actions
  - Article from CAA review, "Pseudo Radar for Oceanic Control"

- The following documentation on the Australian marine sector was collected:
  - Interview Notes responding to framework questionnaire



Philippines

Republic of the Philippines

General Description

The Philippines is an archipelago located in southeastern Asia between the Philippine Sea and the South China Sea, east of Vietnam. The land area is approximately 298.2 thousand square kilometres with a total coastlines of 36 289 kilometres. The terrain is mostly mountains with narrow to extensive coastal lowlands. The total population as of December 1995 was 68.6 million.

The transportation infrastructure of the Philippines consists of: 1 057 km of railroad (259.68 km of which are closed lines); 160 970.241 km of highways consisting of local and national roads (26 846.613 km of which are paved; and 3 129 km of inland waterways that are limited to shallow draft (less than 1.5 m) vessels. There are also 15 primary ports and 205 airports consisting of seven international, 12 trunkline, 37 secondary, 34 feeder and 115 private aerodrome/airstrip.

Trade

Domestic output in this primarily agricultural economy failed to grow in 1992 and rose slightly in 1993. However, a marked increase in capital goods imports, particularly power generating equipment, telecommunications equipment, and electronic data processors, contributed to 43% annual growth in 1992-94. In particular, exports were valued at U.S.$ 13.4 billion in 1994 with the primary export commodities being electronics, textiles, coconut products, copper and fish. The Philippines main export trading partners are the United States, Japan, Germany, Hong Kong and the United Kingdom. The primary imports were Raw materials, capital goods and petroleum products and were valued at U.S.$ 21.3 billion in 1994. The economy's major import trade partners are Japan, the United States, Chinese Taipei, Singapore and the Republic of Korea.

Aviation SN&C Implementation

General Description

The Air Transportation Office of the Department of Transportation and Communications is responsible for air navigation services. These services are provided from a network of facilities: two Area Control Centres (ACC), three Approach Control Offices, seven Tower/Approach Control facilities, 13 Towers and 36 Flight Service Stations both international and domestic, three Flight Operation Briefing Stations, Aeromobile Service and Aeronautical Fixed Service.

Traffic

The strongest growth is forecast to take place between the Philippines and Northeast Asia. Traffic to and from South Asia will also experience a strong growth, especially between 2000 and 2010. However, the forecast rates of growth are applied on a very small base which means only 37 000 more South Asian passengers in 2010 than 2000.

Total international scheduled passenger traffic to and from the Philippines is forecast to grow at 8.9% average per annum between 1993 and 2000 and at 7.8% per annum thereafter. By 2010 this traffic will amount to 18 million passengers. Northeast Asia will remain the most important region for traffic to and from the Philippines. Its share of the total will increase to 57%, from 53% in 1993. The most important economy of origin-destination for the Philippines will be Hong Kong with 4.4 million passengers by 2010 (or 20% of total international passenger traffic). Table 1 presents a summary of the forecast international passenger traffic as well as aircraft movements. Also included in the table are forecasts for domestic passenger and aircraft traffic.

Table 1: Forecasts of Passengers and Aircraft Traffic (1996 - 2010)

	1995	1996	2000	2005	2010
International					
Passengers	6 560 008	7 011 743	9 190 965	12 890 804	18 080 019
Aircraft	37 311	40 138	48 048	59 022	70 435
Domestic					
Passengers	4 014 831	3 837 002	4 735 376	6 159 572	8 012 362
Aircraft	37 444	32 972	37 220	43 021	49 873

Source: Air Transportation Office

Present & Future Infrastructure

The Philippines' present infrastructure consists of conventional ground-based equipment: ILSs, DVORs, DMEs and NDBs. While the Philippines will eventually implement some components of SN&C technology, the economy's future plans are focussed on the establishment of more ground-based navigation facilities such as VOR/DME, NDB and VSAT communication systems.

Highlights of Current SN&C Work

Current SN&C work includes the formation of national and local CNS/ATM committees to conduct the planning for the transition from ground-based equipment to satellite-based systems from the year 2000 onwards. Under consideration by the committees are the utilization of HF and VHF data links, controller to pilot data link communication and ADS through service providers such as SITA and AIRINC.

SN&C Implementation Plans

Plans are currently being finalized by the local CNS/ATM committees for submission to and approval by the national committee. The level of implementation of CNS/ATM will depend upon the funding/budget to be allocated for this purpose. Plans are under consideration for foreign financing of part of this undertaking.

Level of SN&C Implementation (High, Medium, Low)

Given the available information, the Philippines currently has a low level of implementation. The plans for SN&C implementation are now being finalized. The economy is upgrading its ground-based system and has not yet begun implementation of CNS/ATM components.

Issues Identified

The economy indicated that the coordination among economies and organizations is an issue regarding SN&C implementation. In particular, plans need to be coordinated in the adjacent FIR's in the region and requirements for support of different groups need to be identified. It is important to note that actions have been taken to resolve this issue. In particular at the recent CNS/ATM/IC/SG/3 meeting held in Bangkok ICAO Regional Headquarters in October 1996, interaction and coordination between member states particularly those with adjacent FIRs were seriously considered. The plans for nine geographical areas to provide common ground and satellite-based equipment for specific airways were drawn for submission to individual member states at the APANPIRG 7 conference.

Potential Actions Identified

The economy noted that specific actions for the provision of ground and satellite-based equipment in accordance with ICAO recommendations are being identified on a regional basis together with other member states of ICAO in the Asia/Pacific region.

Marine SN&C Implementation

General Description

Several government departments and state organizations have responsibilities in marine sector management: Transport and Communications, Coast Guard, Maritime Industry Authority (MARINA) and the Philippine Port Authority. Jurisdictional coordination is often a challenge. The territorial area of the Philippines covers 300 00 sq km. It comprises 7 100 islands and has 21 base ports.

Traffic

In 1994, the base ports moved 45 million metric tons of cargo. Of this, 56% was containerized, 32% breakbulk, and 12% bulk cargo. Traffic amounted to 81 559 vessels which translates to more that 200 daily calls at base ports. Cargo traffic is anticipated to reach 106 million tons by the year 2000, an increase of 131%. The number of ships carrying forecast cargo is expected to increase to approximately 115 000. Ship calls are expected to increase to 260 000 by 2020 (more that 700 ship calls per day). In 1995 over 50 million metric tons of cargo were handled (51% containerized, 34% breakbulk, and 15% bulk) with 93 981 ship calls.

In 1994, recorded marine passenger traffic was 22.7 million and increased by 2.8 million in 1995 to 25.5 million. This is projected to reach 31.5 million by 2000 and to reach 68 million by 2020 (186 000 passengers per day).

Present & Future Infrastructure

The economy's current navigation systems are comprised of lighthouses and buoys. There is neither surveillance radars nor marine traffic control. Radio coverage is provided ship to ship and ship to shore via VHF and UHF. Coastal radio stations are provided by the Coast Guard. Future plans include the implementation of GMDSS, Inmarsat CES and COPAS-SARSAT Local User Terminal and Mission Control Centre. The GMDSS will include the following components: 15 MF DSC radiotelephone stations; Four NAVTEX stations; 19 VHF radio stations; one Inmarsat ship earth station (land-based) facility; one HF DSC/radio telephone station; and 15 HF voice/telex facilities for internal communications. The Coast

Guard has been advocating the requirement for surveillance radar but a lack of funding has made this a low priority. A vessel traffic service system is planned for development in Manila Bay starting in 1997.

Highlights of Current SN&C Work

Currently, the Philippines marine authorities are planning for the implementation of GMDSS; no other SN&C work is being undertaken at this time.

SN&C Implementation Plans

Present implementation plans schedule GMDSS for operation by 1999, and INMARSAT CES and COPAS-SARSAT approximately 55 months after GMDSS.

Level of SN&C Implementation (High, Medium, Low)

Based on available information, the Philippines has a low level of SN&C implementation. The economy is currently planning to implement search and rescue technologies but not until 1999. There are currently no plans for implementing DGPS and no operational trials have been conducted.

Issues Identified

The following SN&C implementation issues were identified by the Philippines:

- Cost and availability of funds.
- Registry of small vessels and lack of ability to impose requirement to carry SN&C equipment.
- Telecommunications is the responsibility of the private sector (lack of ROI).

Potential Actions Identified

The economy did not identify any potential actions for APEC in the resolution of the identified issues.

Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/rp.html was used.

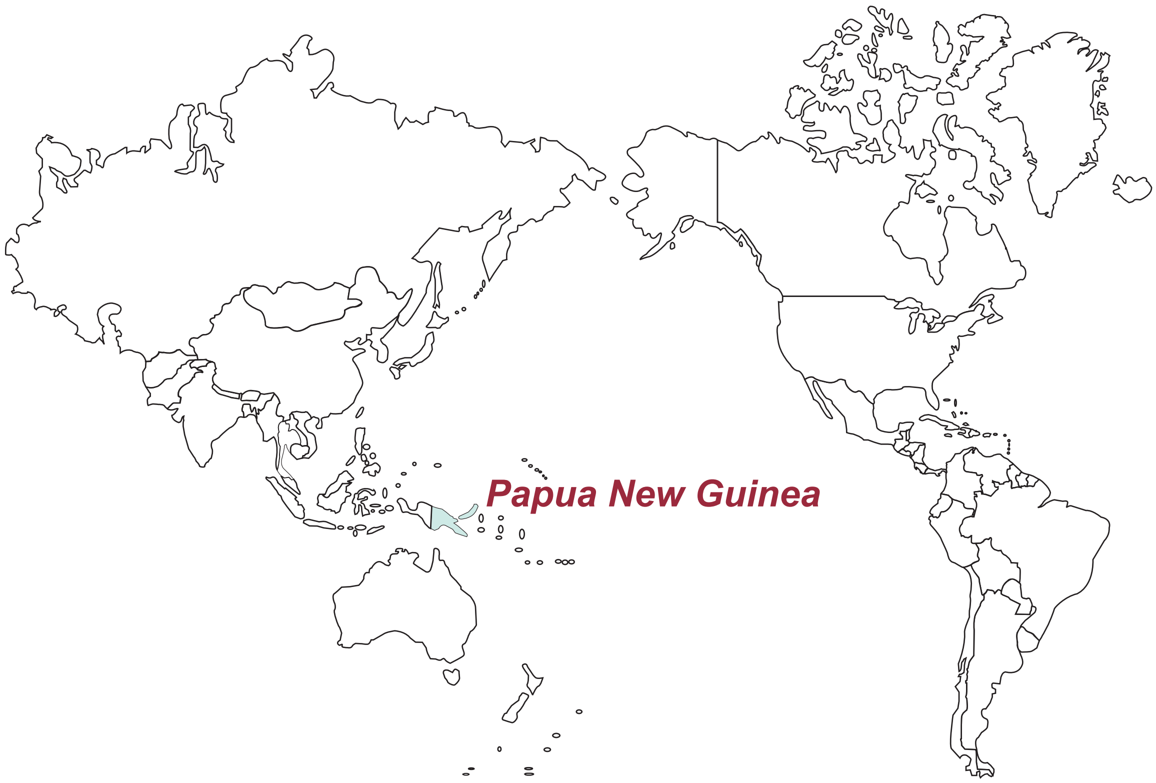
- The following documentation on the Philippines aviation sector has been collected:

  - Trade, Traffic and APEC Report, SN&C Study, September 1996.
  - Response to Framework Questionnaire.

- The following documentation on the Philippines marine sector was collected:

  - Response to Framework Questionnaire.
  - Terms of Reference for the Supply of Global Maritime Distress and Safety System in the Republic of the Philippines.

Papua New Guinea



Papua New Guinea

General Description

Papua New Guinea, located in Southeastern Asia, is a group of islands including the eastern half of the island on New Guinea between the Coral Sea and the South Pacific Ocean. The land area is approximately 451.7 thousand square kilometres with a total coastline 5 152 km long. The terrain consists of mostly mountains with coastal lowlands and rolling foothills. The total population as of July 1995 was 4.3 million.

Papua New Guinea transportation infrastructure development has been limited by the difficulties and high cost due to the mountainous terrain. The economy has no railroad and 19 200 km of highways of which only 640 km are paved. Papua New Guinea has extensive inland waterways, 10 940 km, because of the many islands. There are five primary ports which are located at Kieta, Lae, Madang, Port Moresby and Rabaul and a total of 505 airports (430 with paved runways and 75 with unpaved runways).

Trade

Papua New Guinea is richly endowed with natural resources, but exploitation has been hampered by the rugged terrain and the high cost of developing an infrastructure. Mining of numerous deposits, including copper and gold, accounts for about 60 percent of export earnings. In 1994 exports were valued at U.S.$ 2.4 billion with the main export commodities being gold, copper ore, oil, logs, palm oil, coffee, cocoa and lobster. The economy's primary export partners are Australia, Japan, the United States, Singapore and New Zealand while their main import partners are Australia, Japan, the United States, New Zealand and the Netherlands. Import commodities include machinery and transport equipment, manufactured goods, food, fuels and chemicals; in 1994 imports were valued at U.S.$ 1.2 billion.

Aviation SN&C Implementation

No information was available.

Marine SN&C Implementation

No information was available.

Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/pp.html was used.

Singapore


Singapore


Johor Baharu
Sembawang
Johore Strait
Woodlands
Kampong Kranji
Thong Hoe
Bukit Mandai
Ama Keng
Seletar Reservoir
Nee Soon
Seletar
Punggol
Pulau Ubin
Serangoon
Changi
SINGAPORE
Choa Chu Kang
Bulim
Bukit Panjang
Peirce Res.
Paya Lebar
Yan Kit
PAYA LEBAR INTL. AIRPORT
Bukit Timah
Jurong
Lokyang
Tuas
Bedok
Siglap
Pasir Panjang
SINGAPORE
Buona Vista
Pulau Ayer Chawan
Pulau Ayer Merbau
Mt. Faber
Pulau Brani
Sentosa

Singapore

General Description

Singapore consists of a number of islands in southeastern Asia and lies between Malaysia and Indonesia. The land area is approximately 623 square kilometres with a coastline 193 km long. The terrain is lowlands with a gently undulating central plateau that contains a water catchment area and nature preserve. The total population as July 1995 was 2.9 million.

Given the very small land area of Singapore, the economy has not need to develop a large transportation infrastructure. There are 38.6 km of railroad, 2 883 km of highways of which 99% are paved, and no inland waterways. There is an international port with six terminals to accommodate all types of vessels and two civil airports with paved runways.

Trade

Singapore has an open entrepreneurial economy with strong service and manufacturing sectors and excellent international trading links. In 1994, exports boomed, led by the electronics sector, particularly U.S. demand for disk drives. Exports were valued at U.S.$ 96.4 billion with the primary export commodities being computer equipment, rubber and rubber products, petroleum products and telecommunications equipment. Singapore's main export trade partners are Malaysia, the United States, Hong Kong, Japan and Thailand. In the same year, imports were valued at U.S.$ 102.4 billion with the primary import commodities being aircraft, petroleum, chemicals and foodstuffs. The economy's major import partners are Japan, Malaysia, the United State, Chinese Taipei and Saudi Arabia. Table 1 provides a summary of historical trade.

Table 1 Summary of External Trade (S$ Billion)

	1960	1970	1980	1990	1995
Exports	3.48	4.76	41.45	95.21	167.51
- Domestic Exports	0.22	1.83	25.80	62.75	98.47
- Re-exports	3.26	2.92	15.65	32.45	69.04
Imports	4.08	7.53	51.35	109.81	176.31
Total Trade	7.55	12.29	92.80	205.2	343.83

Source: http://www.gov.sg/mti/mti6.html

Aviation SN&C Implementation

General Description

The Civil Aviation Authority of Singapore (CAAS) was established in 1984 to spearhead the development of civil aviation in Singapore. The functions of the CAAS are: Regulatory and Advisory Services; Air Services Development; Airport Management and Development; and Airspace Management and Organisation. The Singapore airspace consists of one Flight Information Region.

Traffic

Total international scheduled passenger traffic to and from Singapore will increase at an average annual rate of 7.7% between 1993 and 2000, and 6.6% to 2010, exceeding 59 million passengers by 2010. Southeast Asia will remain the most important region for Singapore. Its share of the total will account for 40% of the total in 2010, an increase from 46% in 1993. The most important country of origin-destination for Singapore will be Australia, with 9.6 million passengers in 2010. The geographical position of Singapore has favoured its role of gateway to Australia and has become a hub for *Qantas*, distributing its European traffic converging on Singapore between the various regional airports in Australia. Its share of the total will increase from 8.5% in 1993 to 16% in 2010.

Recent air services agreement between Singapore and Indonesia will stimulate regional flights between Singapore and many regional airports in Indonesia. It will increase traffic flow, especially tourism between Singapore and Indonesia.

Present & Future Infrastructure

Singapore has been actively developing its air navigation system infrastructure. The present system not only includes conventional ground-based aids (ground communication links, HF and VHF voice, NDBs, VOR/DMEs, primary and secondary radars, and ILSs) but also ATM automation, satellite voice and data link communications, and ADS. The economy have a full operational CNS/ATM system with the implementation of VHF data link, DGNSS, LAAS and ATN. Table 2 summarizes the present and future technologies for Singapore's air navigation system.

Highlights of Current SN&C Work

Singapore fully supports the implementation of SN&C technology and has carried out the following activities:

- Implemented SN&C such as ADS, controller/pilot data link communications (CPDLC), and ATM features in Singapore's new ATC system;

- Implemented satellite voice communications;

- Preparing for ATN during the replacement of Singapore's Automatic Message Switching System;

- Planning to implement satellite navigation for Changi and Seletar airports; and

- Initiated meetings/seminars focussed on actual implementation of SN&C such as hosting of a meeting in Singapore in early December 1996 to develop CNS/ATM routes in the Asia Region.

SN&C Implementation Plans

Given Singapore's implementation plan, the economy will have a full CNS/ATM system operational by 1999. In particular the following SN&C components will be implemented by the given date:

- GPS overlay procedures - 1997;

Table 2 Current and Future ANS Infrastructure

Conventional Equipment/ Capability	Airspace where the Equipment/ Capability is Currently Used: Route	Terminal/ Approach Control	Airport/ Aerodrome Control	CNS/ATM Equipment/ Capability	Airspace where the Equipment/ Capability is Currently Used: Route	Terminal/ Approach Control	Airport/ Aerodrome Control
Ground Comm Links	●/○	●/○	●/○	Satellite Communications	●/○		
HF voice	●/○			VHF Data Link	○		
VHF voice	○	●	●	HF Data Link			
Omega				SSR Mode S Data Link			
NDB	●	●	●	SSR Mode S Surveillance			
VOR	●	●	●	DGNSS			○
DME	●	●	●	LAAS			○
Primary Radar	●/○	●/○		RAS/MSAT			
SSR Mode A/C	●/○	●/○		ADS	●/○	○	
ILS			●/○	ATM Automation	●/○	●/○	
MLS				Other (Please Specify)			
VASIS/PAPIS			●/○				
SAT COMM - AFTN ORAL ATS			●				

Source: Economy's Response to Questionnaire

● Current Infrastructure ○ Future Infrastructure ●/○ Both Current & Future Infrastructure

- Local Area Augmentation System - 1997;

- VHF data link - 1998; and

- ATN system - 1998/99.

Level of SN&C Implementation (High, Medium, Low)

Singapore has a high level of SN&C implementation. The economy is committed to the development and implementation of a satellite-base air navigation system. Satellite communications, both voice and data, and ADS have been operational in the economy's airspace since 1995. The CAAS plans to implement a full CNS/ATM system which will be operational by 1999.

Issues Identified

For Singapore, potential issues surrounding the implementation of SN&C technologies in the aviation sector include costs of the systems and user demand. The CAAS presented some concerns regarding:

- Lack of international standards and procedures for SN&C and those parts of the air traffic control system which are affected by its implementation.

- Challenge of implementing SN&C in a coordinated, seamless and timely manner.

- Satellite communications now rely on Inmarsat-2 satellites to provide CPDLC. More such communications satellites are required for redundancy purpose.

- Presently, two systems of navigation satellites are available for worldwide navigation namely, GPS from the United States and GLONASS from Russia. Both systems were originally meant for military usage and are only available recently for civilian use. As a result, many economies in the world have the following concerns about satellite navigation:

- No control over usage of the navigation satellites especially in times of crisis;
- Responsibility during aircraft incidents; and
- Cost of future usage of the navigation satellites once the free offer period is up.

Potential Actions Identified

The CAAS indicated that the expected role of APEC in fostering SN&C implementation in Singapore and the Asia-Pacific region includes:

- Facilitating training and information exchange (It is expected that APEC will play a supporting role to ICAO in this area); and

- Promoting common applications for aviation and marine uses such as the use of common equipment for satellite navigation purposes.

Marine SN&C Implementation

General Description

The Maritime and Port Authority of Singapore (MPA) oversees all maritime activities for Singapore. The marine infrastructure for which MPA is responsible includes: an international port; marine traffic control centre, and radio advisory station. Maritime search and rescue operations are co-ordinated b the Shipping Division of MPA while vessel traffic services are provided by Port Division. Close co-operation is maintained with other organisations which play important roles in such operations. They are the Singapore Telecom (who operate the coast radio station and INMARSAT land earth stations), the Civil Aviation Authority of Singapore (CAAS), Republic of Singapore Airforce (RSAF), Republic of Singapore Navy (RSN), Singapore Civil Defence, Ministry of Health, Ministry of Home Affairs and Police Coast Guard.

Traffic

The Singapore Port is one of the busiest ports in the world. Only Hong Kong surpasses Singapore in container through put volume; in 1994 Singapore Port handled 10.4 million TEUs (or 20-foot equivalent units; the standard container measure), while Hong Kong processed 11.1 million TEUs. For Singapore, the 1994 volume saw a 15% increase over that of 1993. Since 1990 the port has experienced a 99% increase in container volumes. Table 3 presents estimated intra Asia containerized cargo movements for 1993. Ship arrivals have also been increasing steadily at the port; in 1989 there were 38, 942 by 1993 that had increased by 138% to 92,655.

Table 3 Estimated Intra-Asia Containerized Cargo Movements (TEUs)

Destination Origin	Taiwan	Hong Kong	South Korea	Philippines	Thailand	Malaysia	Indonesia	Total
Singapore	51,800	52,900	14,400	15,000	20,700	41,400	26,400	222,600

Source: Compiled on the basis of data supplied by Kaiun (Shipping), various issues, 1993.

Present & Future Infrastructure

Singapore's present infrastructure consists primarily of communication equipment. In particularly the following types of communication are available: MF, HF and VHF radiotelephony; Maritime Satellite Telephone Service via INMARSAT A, C and M; and radio and satellite telex. MPA is planning to implement all facets of the GMDSS to comply with international standards. Adequate traditional navigational aids such as lihgt buoys, racons, lightbeacons and lighthouses are available in Singapore waters. MPA is also planning to install a DGPS reference station in the near future.

Highlights of Current SN&C Work

Singapore has developed an extensive satellite communications capability and is planning to instal DGPS and Digital Selective Calling System of GMDSS by 1998.

SN&C Implementation Plans

As mentioned above MPA is planning for implementation of DGPS by the year 1998.

Level of SN&C Implementation (High, Medium, Low)

Based on the available information, Singapore is assessed to have a medium level of SN&C implementation in the marine sector. The MPA's efforts are being directed to the implementation of GMDSS, DGPS and to comply with international standards and to enhance safety of navigation and surveillance in the near future.

Issues Identified

Singapore identified the following issues that may affect implementation of SN&C technology in the marine sector:

- Sovereignty and the requirement for cooperation among neighbouring economies.
- National security and the need for trust among neighbours.
- Costs of implementation and the need for sharing them.
- Different requirements for the technologies among the economies.
- Different laws and regulations among the economies.
- Different levels of technical and operational capabilities among the economies.

Potential Actions Identified

While Singapore did not identify any specific actions for APEC, actions were presented for the following groups:

- Economies - costs must be shared proportionally to the needs and wealth of the states.

- Regional Groups - reasonable allowances must be made to adjust for differences in rules and regulations.

- Other International Groups - IMO, COPAS-SARSAT could ensure that rules and regulations are implemented by all economies.

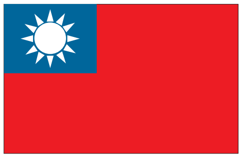
Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

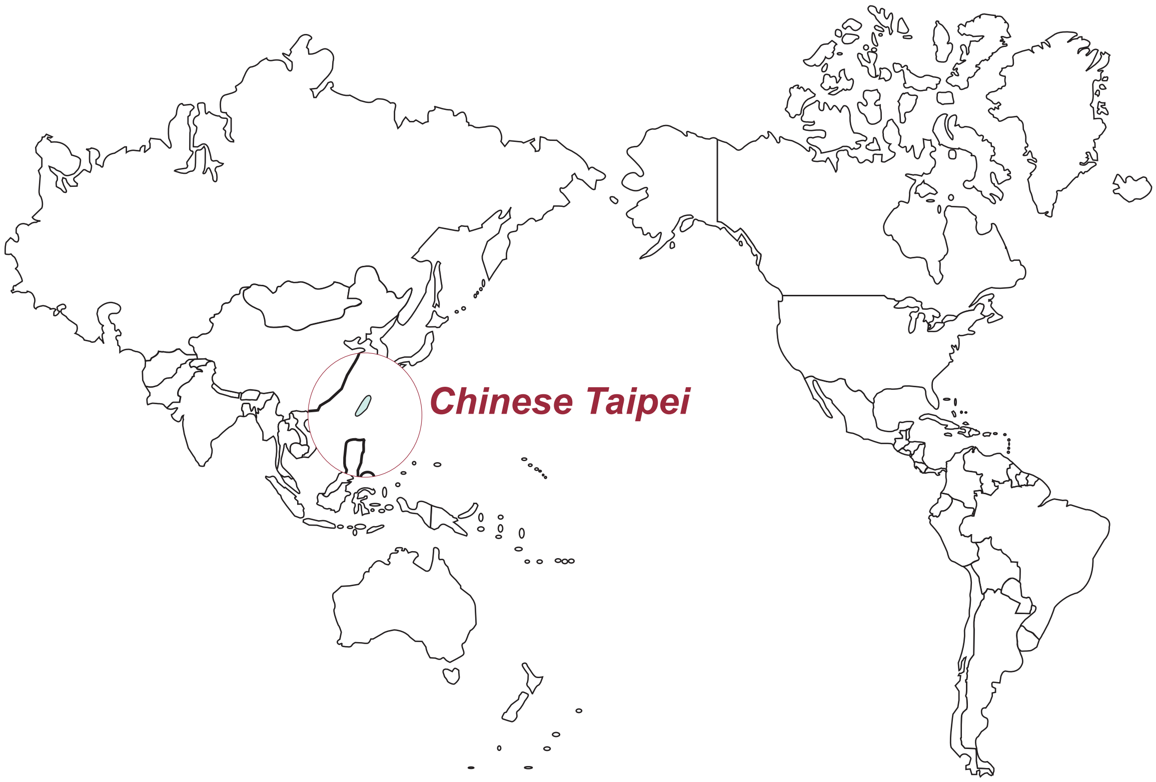
- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/sn.html was used.

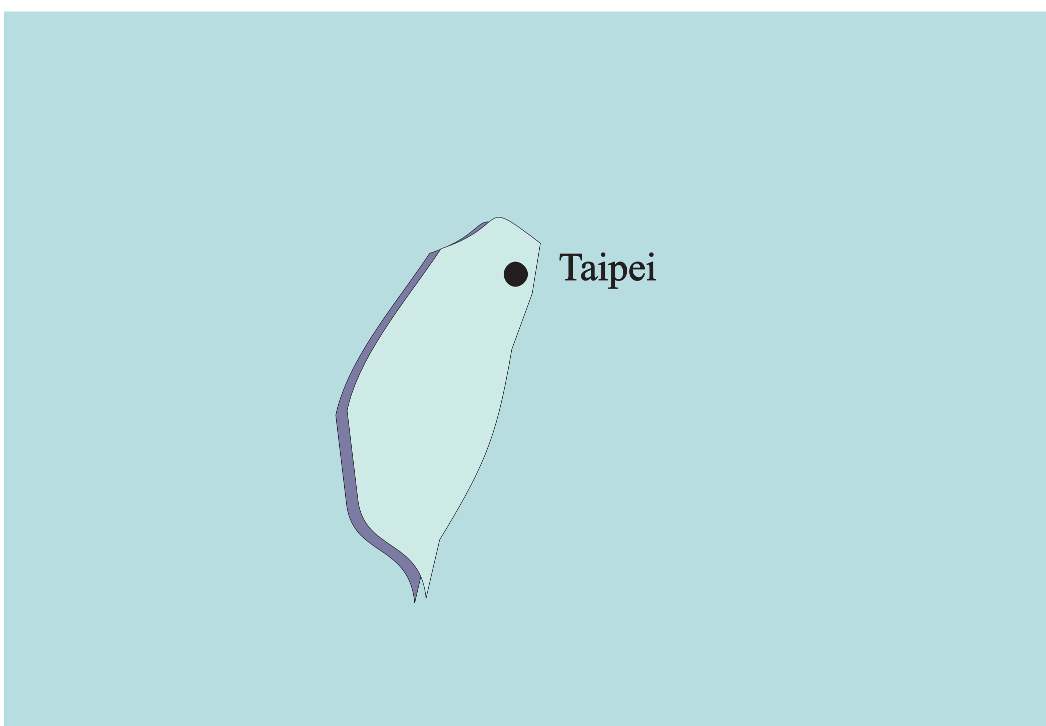
- The following documentation on the Singapore aviation sector has been collected:
  - Response to Framework Questionnaire by CAAS.
  - Response to SN&C Project Request for Possible APEC action from the Ministry of Communications.
  - Background corporate profile information from the CAAS web site, "http://www.changi.airport.com.sg/caas".
  - Asia/Pacific Regional Plan for the New CNS/ATM Systems, Issue 4, Amendment No.1.
  - Trade, Traffic and APEC Report, APEC SN&C Study, September 1996.

- The following documentation on the Singapore marine sector was collected:
  - Response to Framework Questionnaire by MPA.
  - Documents from Singapore Telecom.
  - Maritime Search and Rescue Plan.
  - Singapore Port Statistics.
  - Trade, Traffic and APEC Report, APEC SN&C Study, September 1996.



Chinese Taipei





Chinese Taipei

General Description

Chinese Taipei is a group of islands in Eastern Asia off the southeastern coast of China and north of the Phillippines. The islands border the East China Sea, the Philippine Sea, South China Sea and Taiwan Strait. The land area is approximately 32.3 thousand square kilometres with a coast line stretching 1 448 km long. The terrain in the eastern two-thirds consists mostly of rugged mountains and flat with gently rolling plains in the west. The total population as of July 1995 was 21.5 million.

Given Chinese Taipei's small land area, less transportation infrastructure is required. There are 4 600 km of railroad; 20 041 km of highways of which 85 percent is paved; and no inland waterways. There are five primary ports which are located at Chi-lung, Hua-lien, Kao-hsiung, Su-ao and T'ai-chung. There is a total of 41 airports of which 39 have paved runways.

Trade

Chinese Taipei has a strong capitalist economy with considerable government guidance of investment and foreign trade, and partial government ownership of some large banks and industrial firms. Export growth has been significant and has provided the impetus for industrialization. Traditional labour intensive industries are steadily being replaced with more capital- and technology-intensive industries. In 1994, total exports valued U.S.$ 93 billion with the prime export commodities being electrical machinery, electronic products, textiles and footwear. The economies major export partners were the U.S., Hong Kong, EC countries and Japan while the major import partners were Japan, the U.S. and EC countries. Estimates for 1994 put imports at U.S.$ 85.1 billion; imports consisted mainly of machinery and equipment, electronic products, chemicals, iron and steel and crude oil.

Aviation SN&C Implementation

General Description

The Ministry of Transportation and Communications (MOTC) is charged with the administration of all transportation and communications operations and enterprises in the Republic of China. Airports and flight navigation services are operated by the Civil Aeronautics Administration under this ministry. Air traffic control services are provided through one Area Control Centre (ACC) and three Terminal Control Centres. The economy is responsible for the Taipei Flight Information Region (FIR) which was established in 1953. This FIR is adjacent to Hong Kong, Manila and Haha FIRs respectively, with several major international air routes passing through it. The CAA also oversees three international airports, five domestic airports and eight auxiliary airports.

Traffic

Total international scheduled passenger traffic to and from Chinese Taipei will grow by 11.3% per annum between 1993 and 2000 and 7.1% per annum thereafter to 2010. Northeast Asia will remain the most important region for traffic to and from this economy. Its share of the total will be 56% in 2010, a significant decrease from 62% in 1993 and 80% in 1985. The main economy of origin and destination for Chinese Taipei will become Hong Kong in 2000. But by 2010 this is likely to shift to the rest of China. Traffic between China and Chinese Taipei is expected to reach 11.7 million passengers by 2010.

Present & Future Infrastructure

Chinese Taipei's air traffic control system currently relies on conventional ground-based systems. The current systems include:

- Various ground-based voice communication facilities;
- Nine NDBs;
- Four VOR/DMEs;
- Two LDA/DMEs;
- Two VORTACs;
- Nine ILS/DMEs;
- Three MLS/DMEPs;

- Three airport surveillance radar (ASR); and
- An Air Traffic Control Automation System (ATCAS).

Near future is the installation of new Long Range Radar and Terminal radar facilities and the expansion of the existing computer display systems to accommodate the additional air traffic capacity. While the specifics and timing for transitioning to SN&C technologies has not been outlined, the economy is committed to the timely expansion and establishment of air routes and the upgrading of navigation facilities. As such it is expected, that Chinese Taipei will implement those components of SN&C that will be beneficial to the economy and the users.

Highlights of Current SN&C Work

Chinese Taipei is conducting investigations into the possible use of Area Navigation (RNAV) including the use of the Global Positioning System (GPS) to meet future requirements.

SN&C Implementation Plans

No specific implementation plans for transition to SN&C technologies were provided.

Level of SN&C Implementation (High, Medium, Low)

Chinese Taipei has a low level of SN&C implementation. Initial investigations into RNAV and GPS have just begun. The economy has not outlined any implementation plans or begun operational trials.

Issues Identified

No specific issues were identified.

Potential Actions Identified

The possible roles that APEC may play in the implementation of SN&C technologies in the region include:

- Providing technical data or at a minimum where data can be obtained for the SN&C technologies. The information is changing rapidly and a central office need to provide methods as to how, where, or what people have specific knowledge.

- Implementing methods to exchange information between various economies.

- Coordinating regulations and overall global implementation dates to assist with global planning efforts.

Marine SN&C Implementation

General Description

Sea transportation consists of marine shipping companies, harbours and maritime navigation/communication services. Marine shipping companies are operated by government agencies and private corporations, while all harbours are operated by the various harbour bureaus under the Chinese Taipei Provincial Government. The Institute of Transportation under MOTC is responsible for the maritime navigation/communication services.

Traffic

The Taiwan Strait is one of the busiest shipping routes in the world. Traffic through this Strait, on passage to and from the ports of Chinese Taipei, was estimated to be over 400 ships per day. In season, this scene is further complicated by large numbers of pleasure crafts and thousands of fishing vessels, the latter being attracted by the four rich fishing grounds in the Strait. With an average of more that one hundred marine accidents occurring in this area every year, the safety of navigation in these waters has become a major concern of maritime safety.

Main intra-Asia ports container throughput volume, in thousand TEUs, from 1986 to 1993 was 4 105; 4 772; 4 889; 5 278; 5 451; 6 127; 6 635; and 7 190 respectively. Estimated containerized cargo movements for 1993 in TEUs were: Hong Kong, 195 500; S. Korea, 29 900; Singapore, 58 900; Philippines, 19 000; Thailand, 26 500; Malaysia, 47 200; and Indonesia, 41 400. The total containerized cargo movements from Chinese Taipei in 1993 were 418 400 TEUs.

Present & Future Infrastructure

The economy's current maritime communication and navigation system uses ground-based conventional navigation equipment. Voice communications is achieved via VHF, UHF and HF radio frequencies. Vessel traffic service projects of two major harbours in Chinese Taipei named Keelung Harbour and Kaohsiung Harbour are under construction. Planning to improve the safety of vessel traffic in the harbour is underway; moreover a traffic separation scheme near the Keelung Harbour water area is being considered.

Chinese Taipei is investigating the possibility of being covered under the SAR network in the Asia-Pacific area. The economy expects to enhance or develop their current SN&C system to improve maritime safety surrounding the economy's waters.

Highlights of Current SN&C Work

No information was available on current SN&C work.

SN&C Implementation Plans

No information was available on SN&C implementation plans.

Level of SN&C Implementation (High, Medium, Low)

Given the available information it was not possible to assess the level of SN&C implementation for the marine sector in Chinese Taipei.

Issues Identified

No issues associated with the implementation of SN&C technologies were identified.

Potential Actions Identified

No potential actions for APEC were identified.

Data Sources

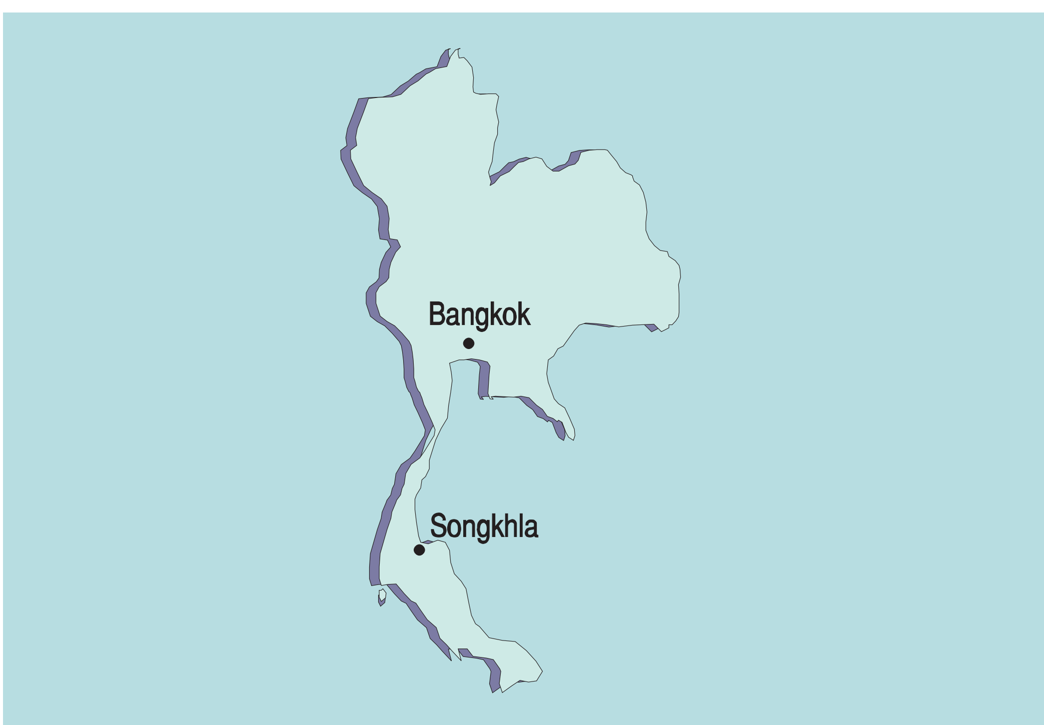
A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/tw.html" was used.

- The following documentation on the Chinese Taipei aviation sector has been collected:
  - Information found on the CAA at the MOTC's web site, "http://www.motc.gov.tw"
  - "Improvements of Flight Safety and Security in Taipei FIR" paper presented at the Transportation Working Group, Ninth Meeting in Vancouver.
  - Trade, Traffic and APEC Report, APEC SN&C Study.

- The following documentation on the Chinese Taipei marine sector was collected:
  - Response to SN&C Project Request for suggestions on possible APEC actions
  - Trade, Traffic and APEC Report, APEC SN&C Study.

Thailand



Thailand

General Description

Thailand is located in southeastern Asia bordering the Andaman Sea and the Gulf of Thailand. The land area is approximately 511.8 thousand square kilometres with a coastline of 3 129 km in length. The terrain consist of a central plain, Khorat plateau in the east, and mountains elsewhere. The population as of June 1995 was 60.3 million.

Thailand has developed a transportation infrastructure which consists of: 3 940 km of railroads; 77 697 km of highways of which approximately half are paved; two major international ports, Bangkok and Laem Chabang; and 105 airports of which 90 have paved runways. There is also 3 999 km of principal waterways; 3 701 km with navigable depths of 0.9 m or more throughout the year and numerous minor waterways navigable by shallow-draft native craft.

Trade

One of the more advanced developing economies in Asia, Thailand depends on exports of manufactures and the development of the service sector to fuel the economy's rapid growth. Much of Thailand's recent imports have been for capital equipment, suggesting that the export sector is poised for growth. In 1994, exports were valued at U.S.$ 46 billion with the primary commodities being machinery and manufacturers, and agricultural products and fisheries. The economy's main export trading partners are the United States, Japan, Singapore, Hong Kong and Germany. In the same year, the primary imports were capital goods, intermediate goods and raw materials and consumer goods which were valued at U.S.$ 52.6 billion. Thailand's major import trading partners are Japan, the United States, Singapore, Germany and Chinese Taipei. Table 1 summarizes exports and imports by Thailand's trading partners for the years 1995 and 1994; Table 2 summarizes the data by commodity.

Table 1: Summary of Exports and Imports by Partner (million baht)

Trade Partner	1994		1995	
	Exports	Imports	Exports	Imports
ASEAN	200 570	177 645	269 141	224 413
Brunei	1 206	4 595	1 578	7 208
Indonesia	11 069	11 355	20 115	16 625
Malaysia	27 632	66 366	38 397	81 595
Philippines	5 612	8 885	10 366	14 940
Singapore	155 051	86 444	198 685	104 045
EU	169 385	185 280	204 580	255 733
U.S.	239 098	162 064	249 657	212 507
Japan	194 274	413 323	236 083	541 132
Hong Kong	59 989	17 362	72 888	18 663
China	23 338	34 898	40 406	52 193
Taiwan	24 690	69 366	33 574	84 289
Saudi Arabia	10 932	13 256	13 749	14 239
Australia	16 148	27 106	19 485	33 269
South Korea	14 372	49 746	19 801	61 223
USSR	8 486	23 812	11 753	32 223
Others	176 318	194 637	235 035	235 306
Total	1 137 600	1 369 035	1 406 158	1 765 567

Source: http://www.bangkokbank.co...n_thai/trade_partner.html

Table 2: Summary of Imports and Exports by Classification/Sector (million baht)

Foreign Trade	1993	1994	1995
Imports by Economic Classification			
Consumer Goods	114	145	182
Intermediate Products & Raw Materials	349	395	510
Capital Goods	501	614	802
Fuel and Lubricants	86	92	117
Others	116	124	157
Total Imports	1 166	1 370	1 768
Exports Classified by Sector			
Agriculture	111	130	158
Fisheries	56	68	71
Mining	6	7	8
Manufacturing	753	923	1 153
Others	10	10	16
Total Exports	936	1 138	1 406

Source: http://www.bangkokbank.co...n_thai/foreign_trade.html

Aviation SN&C Implementation

General Description

The Ministry of Transport and Communications has responsibility as the aviation regulatory in Thailand while the Aeronautical Radio of Thailand, Ltd. (AEROTHAI) has the responsibility of providing air traffic services in the economy's airspace. Thailand's airspace consists of the following areas:

- Bangkok Flight Information Region (FIR) embracing the area of 413 366.4 square kilometres.

- Area of Responsibility (AOR) in South China Sea covering an area of 42 596 square kilometres. This area is assigned by Vietnam to AEROTHAI to provide air traffic control service to aircraft flying at the altitude of 24 500 feet and higher.

- Upper Flight Information Region (UIR) over Cambodia's airspace and covering an area of 100 008 square kilometres. This area is assigned by Cambodia to AEROTHAI to provide air traffic control services to aircraft flying at the altitude of 19 500 feet and higher

The total area that Thailand has to provide air traffic services is 555 970.4 square kilometres which is approximately 0.1% of the global airspace. It consists of oceanic, continental and terminal areas with both high and low air traffic density. Air traffic control of the whole areas is provided by the Bangkok Area Control Centre. There are six international airports in Thailand, namely Bangkok, Chiang Mai, Hat Yai, Phuket, Utaphao and Chiang Rai as well as 23 domestic airports.

Traffic

Thailand is strategically located so as to enable it to be the hub of Southeast Asia civil aviation activities. At present there are 73 airlines from 59 countries flying into Thailand. The number of international passengers at Bangkok International Airport in 1994 was 18.8 million which was a 9.8% increase over the previous year.

The most important traffic generating countries for Thailand in 1994 were Malaysia and Japan. But among the main traffic generating markets, Taiwan achieved the strongest growth, with 28.9% per annum on average during the 1985-1993 period. The most important economy of origin-destination for Thailand will remain Hong Kong , followed closely by Singapore.

Total international scheduled passenger traffic to and from Thailand will increase by 10.5% per annum between 1993 and 2000 and 9.2% per annum to 2010. This traffic will reach 74.6 million passengers by 2010. Among all Thailand's main traffic generating countries, the one which will experience the strongest growth in the future is Taiwan, followed by Japan.

Present & Future Infrastructure

At present air-ground communications for ATS purposes are conducted via VHF and via HF when outside of VHF range. Thailand has established a complete network of radio navigation aids; i.e., NDB, VOR, DME and ILS to provide services to aircraft in all phases of flights. AEROTHAI is operating four primary radars and four secondary radars. These radars provide coverage of the whole Bangkok FIR. The radars can be upgraded to Mode S when needed.

In the future, air-ground communications will make use of all three modes of communications, namely VHF, AMSS and SSR Mode S data link. AMSS communications will be accomplished via Inmarsat satellites; the Communications Authority has established a ground earth station. AEROTHAI will operate the VHF and Mode S data link. ATN Routers will be set up both in the air and on the ground to establish an air-ground and ground-ground networks. The AIRINC 622 specification is being employed in Thailand as an interim measure. GNSS will be used for aircraft navigation en route and the economy is inclined to use DGNSS instead of ILS in the future. The current radio navigation aids will eventually be withdrawn. The economy will implement ADS to provide surveillance in those areas without radar coverage.

Highlights of Current SN&C Work

The Ministry of Transport and Communications has established a CNS/ATM working group with the main objective to develop "Thailand's CNS/ATM Trials and Implementation Plan". The main objective is based on two guidelines, namely the "Global Coordinated Plan for Transition to the ICAO CNS/ATM Systems" and the "Asia/Pacific Regional Plan for the New CNS/ATM Systems" developed by APANPIRG. Thailand has been actively involved in developments, trials and pre-operational demonstrations in all areas of SN&C. In 1997, the economy is scheduled to have AMSS (Airinc 622) and VHF data link operational with ADS coming on line in 1998. Current work is focussed meeting these schedules and continuing with trials particularly of GNSS.

SN&C Implementation Plans

In general Thailand will be able to provide a basic CNS/ATM system for operational use by suitably equipped aircraft in 2000. In particular, the economy will have achieved operational use of the various SN&C technologies in the following years:

- AMSS (AIRINC 622) - 1997;
- VHF data link (AIRINC 622) - 1997;
- ATN - 2000 or earlier;
- Wide Area DGNSS and Local Area DGNSS - 1998;
- GNSS (En route, Terminal) - 1998;
- GNSS (NPA) - 1998;
- ADS via VHF data link - 1998;
- ADS via AMSS - 1998; and
- Mode S Radar - 1998.

Level of SN&C Implementation (High, Medium, Low)

Thailand has a high level of SN&C implementation. The economy has developed detailed implementation plans and has conducted a cost-benefit analysis of CNS/ATM implementation. Trials and demonstrations have been underway for a number of years with a variety of SN&C components. During 1997-1998, the economy will have operational use of AMSS and VHF data link and ADS.

Issues Identified

The economy identified the following issues regarding the implementation of SN&C technologies in the aviation sector:

- Long delay of ICAO Standards and Recommended Practices.
- Incompatibility of implementation schedules among various regions.
- Inconsistency of procedures among the economies.
- Requirements for training.

Potential Actions Identified

Thailand indicated that the following APEC actions would assist with the resolution of implementation issues:

- Dissemination of ICAO CNS/ATM concepts.
- Technical assistance.
- Funding assistance.

Marine SN&C Implementation

General Description

Navigation in Thailand is operated and controlled by the Harbour Department; national development plans are the principal responsibility of this department. The Port Authority of Thailand is responsible for providing marine survey and maintenance, maintenance and dredging of the bar channel (18 km) approaches to Bangkok, as well as the installation and maintenance of navigation aids.

Radio channels of both Bangkok Port and Laem Chabang port are used by several sections and organizations, not all of which are under the control of the port. It sometimes causes congestion and confusion to the communications operations between the port and the vessels.

Traffic

Shipping tonnage at Bangkok Port rose from 14 368 thousand tonnes in 1990 to 17 914 in 1995, an increase of over 25%. From 1990 to 1995, container throughput volume has increased by 40% rising from 1 018 thousand TEUs to 1 433 thousand TEUs. Table 3 presents estimated intra-Asia containerized cargo movements for 1993. Ship arrivals have also been increasing steadily at the port; in 1989 there were 2 255 by 1995 that had increased by 14% to 2 579.

Table 3: Estimated Intra-Asia Containerized Cargo Movements (TEUs)

Destination Origin	Taiwan	Hong Kong	South Korea	Singapore	Philippines	Malaysia	Indonesia	Total
Thailand	34 500	36 800	11 500	27 600	4 800	5 800	5 500	126 500

Source: Compiled on the basis of data supplied by Kaiun (Shipping), various issues, 1993.

Present & Future Infrastructure

Marine communications in Thailand are accomplished via local radio stations and radio telegraphy systems (HF, MF and VHF). Communications equipment in Bangkok Port are not up-to date and there are many types of equipment. This causes difficulty and high cost of maintenance. At Laem Chabang Port there are two radar systems for a Vessel Traffic System (VTS) and a Marine Control System (MCS) as well as a SSEA BEACON RACON II. Navigation aids include buoys and beacons.

Future changes to the infrastructure are focussed on upgrading the communication systems at Bangkok Port and implement the Global Maritime Distress and Safety System(GMDSS). At the Laem Chabang Port a microwave link station will be installed and possible development of the Vessel Traffic Control Centre may take place. Currently, the economy has no plans for the implementation of DGPS.

Highlights of Current SN&C Work

Current SN&C work is focussed on upgrading the communications at Bangkok Port radio telegraphy (MF, HF and VHF) and implementing GMDSS.

SN&C Implementation Plans

Thailand has no plans for implementing SN&C technologies in the near future.

Level of SN&C Implementation (High, Medium, Low)

Thailand has a low level of SN&C implementation. Current work is focussed on upgrading communications and implementing GMDSS. The economy has not begun any work in the areas of DGPS or ECDIS and has no plans for their implementation in the near future.

Issues Identified

Thailand indicated that the following issues may impede the future implementation of SN&C technologies:

- Jurisdictional coordination between organizations in Thailand.
- The costs and associated funding requirements for implementation of technologies.
- Meeting the training requirements.

Potential Actions Identified

The economy indicated that APEC could provide a role in fostering the implementation of SN&C technologies by providing support in the areas of:

- Funding;
- Technical assistance;
- Planning;
- Development and implementation of regulations; and
- Coordination.

Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/th.html and Bangkok Bank web site, "http://www.bangkokbank.co...n_thai/trade_partner.html were used.

- The following documentation on the Thailand aviation sector has been collected:
  - Response to Framework Questionnaire by the Department of Aviation.
  - Thailand's CNS/ATM Trials and Implementation Plan, Second Edition, Sept. 1995.
  - Thailand's Cost/Benefit Analysis for the Implementation of CNS/ATM Systems.
  - Asia/Pacific Regional Plan for the New CNS/ATM Systems, Issue 4, Amendment No.1.
  - Trade, Traffic and APEC Report, APEC SN&C Study, September 1996.

- The following documentation on the Thailand marine sector was collected:
  - Response to Framework Questionnaire by the Port Authority of Thailand.
  - Trade, Traffic and APEC Report, APEC SN&C Study, September 1996.

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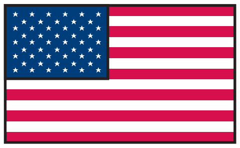
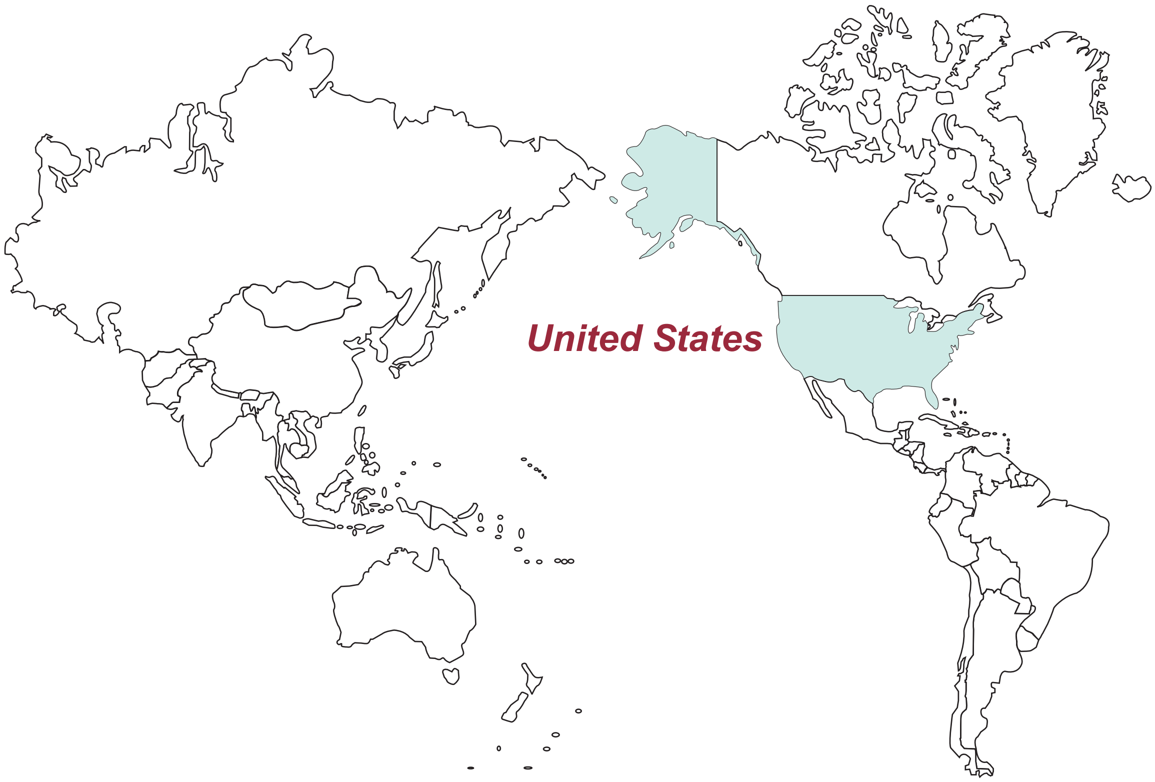


United States



United States

General Description

The United States of America, the world's fourth largest country, a is located in North America between Canada and Mexico and borders both the North Pacific and North Atlantic Oceans. The land area is 9.2 million square kilometres with a coastline 19 924 km long. The terrain varies across the country ranging from a vast central plain to mountains in the west and hills and low mountains in the east. Alaska has rugged mountains and broad river valleys while Hawaii has a rugged volcanic topography. The total population as of July 1995 was 263.8 million.

The United States has developed an extensive transportation infrastructure. The economy has 240 000 km of railroads; 6 243 thousand km of highways of which 58% is paved; and 41 009 km of navigable inland channels exclusive of the Great Lakes. The U.S. has over 20 primary ports with the Port of Los Angeles and Long Beach as the key west coast ports. There are over 15 000 airports (13 114 paved and 1 918 unpaved runways).

Trade

The U.S. has a diverse and technologically advanced economy. The economy is market oriented wit most decisions made by private individuals and business firms and with government purchases of goods and services made predominantly in the marketplace. In 1994, exports were valued at $513 billion with the primary commodities being capital goods, automobiles, industrial supplies and raw materials, consumer goods and agriculturally products. Imports included crude oil and refined petroleum products, machinery, automobiles, consumer goods, industrial raw materials, foods and beverages. In 1994, imports were valued at $664 billion. The U.S.'s major trading partners are Western Europe, Canada and Japan.

Aviation SN&C Implementation

General Description

Air Traffic Services (ATS) of the Federal Aviation Administration (FAA) is responsible for ensuring the safe, efficient operation, maintenance and use of today's air transportation system and meeting the challenges to increase system safety, capacity and productivity in the future. In particular, ATS:

- Controls 200 000 aircraft takeoffs and landing per day.

- Provides 24 hours of air traffic control daily.

- Manages the National Airspace System (NAS) infrastructure by operating and maintaining 32 500 facilities and systems which include, among other things, 61 Automated Flight Service Stations (AFSS), 29 Flight Service Stations (FSS), 21 Air Route Traffic Control Centres (ARTCC) and 352 Airport Traffic Control Towers (ATCT).

- Maintains 8 200 terminal instrument flight procedures and 9 000 airway segments.

- Conducts over 11 000 flight inspections nationally and internationally each year to preserve the safety, quality, and reliability of the airspace system.

- Assigns and protects more than 40 000 aeronautical radio frequencies used in air traffic control.

- Directs the modernization of the NAS infrastructure.

Traffic

No forecast aircraft traffic data or passenger data was available. Historical air traffic activity at airport traffic control towers by aviation category for fiscal years 1989 through 1993 is presented in Table 1.

Present & Future Infrastructure

The United States has implemented an extensive ground-based communication, navigation, and surveillance infrastructure. For example, the FAA operates over 900 ILSs, 26 MLSs, over 725 NDBs, and over 900 VOR/VORTAC; Loran-C and Omega are also used for air navigation. The FAA is committed to providing satellite navigation services adequate for all phases of flight through the use of wide area and local area augmentation. GPS has already being used for en route, terminal areas and non-precision approaches.

Table 1: Air Traffic Activity at Airport Traffic Control Towers

Year	Airport Operations				Total
	Air Carrier	Air Taxi	General Aviation	Military	
1989	12 519 891	8 296 725	37 753 005	2 775 552	61 345 173
1990	12 858 718	8 837 671	39 169 795	2 802 696	63 668 880
1991	12 504 124	8 899 633	37 578 308	2 503 517	61 485 577
1992	12 435 044	9 307 272	36 945 360	2 784 051	61 471 727
1993	12 581 148	9 675 955	35 227 770	2 623 280	60 108 153

Source: “www.bts.gov/smart/.../chap02/tab2-3/tab2-3.txt

Communication systems include conventional systems such as VHF and HF voice; and CNS/ATM systems such as satellite communications both voice and data (non-standard) are currently under trial. Surveillance is provided using primary, secondary and Mode S radars with trials underway for ADS. The United States plans to implement a full CNS/ATM system with the long-term goal of transitioning to “free flight”. The various ground-based navigation systems (including VOR with associated DME, TACAN, NDB, Omega, Loran-C and ILS) will be phased out gradually over approximately a fifteen-year period beginning in 2000 with a rapid phase out of any systems remaining after 2010.

Highlights of Current SN&C Work

The United States is actively involved in planning, developing and transitioning to CNS/ATM systems. In particular, the FAA has embarked on an aggressive program to make satellite-based navigation technology available for the use throughout the NAS. The Satellite Navigation Program is well underway and its focus is:

- Technical - Wide Area Concepts, Local Area Concepts, Advanced R&D;
- Acquisition - Wide Area Augmentation System (WAAS), Local Area Augmentation System (LAAS);

- Operational - Standards/Certification, Procedures, Air Traffic, Implementation, Facilities; and

- Institutional - International, Internal U.S. Government, External U.S. Government.

Oceanic CPDLC and ADS trails are also being conducted by the United States. Both the Oakland, California and Anchorage, Alaska air traffic control facilities have satellite data link capabilities (based on the ARINC 622 specification) although transition to an operational ADS has fallen behind schedule. For domestic, investigations are underway to determine the appropriate systems for data link. Under consideration are VHF, HF, and Mode S.

SN&C Implementation Plans

As presented in the Canada/Mexico/United States Regional CNS/ATM Implementation Plan, the United States will have initial operations of the following systems in the given years:

- CPDLC & ADS (ARINC 622 based) - 1996;
- ATN - 1999;
- CPDLC & ADS (ATN based) - 1999;
- WAAS - 2000;
- LAAS - 2000; and
- Satellite Voice - 2000.

Level of SN&C Implementation (High, Medium, Low)

The United States is considered to have a high level of implementation. The economy has developed a detailed plan for the transition to a full CNS/ATM system and eventually "free flight". The United States is conducting operational trials of ADS with plans for full operations in the near future. Supplemental use of GNSS has been approved for en route, terminal and non-precision approaches. The Wide Area Augmentation System (WAAS) is under development and is scheduled for implementation in 2000. The United States plans to implement a full CNS/ATM system and will have initial operations of the primary SN&C technologies by 2000.

Issues Identified

No information was available from the economy on the transition issues to CNS/ATM that are considered to be key ones.

Potential Actions Identified

The following were identified as potential actions that APEC may undertake to assist with SN&C implementation in the region:

- Continue support towards implementation of Asia-Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG) Plan within the economies.
- Reinforce the regional economies to support their CNS/ATM committees.
- Provide funding/venues to assist APANPIRG in its education opportunities and information exchange of CNS/ATM developments.
- Ensure resources are available to the planning and implementation efforts; such as WGS-84 surveys to accommodate satellite-based navigation.

Marine SN&C Implementation

General Description

The United States Coast Guard (USCG) is the primary federal agency with maritime authority for the United States. The Coast Guard's for main missions are maritime law enforcement, maritime safety, marine environmental protection and national security.

Traffic

No information was available for vessel traffic movements at U.S. ports. However, Table 2 presents the number of vessels that transited seven of the eight U.S.CG VTSs from January 1992 through December 1993.

Table 2: Vessel Traffic Services Currently Operating

Facility	Total Vessel Transits		
	1 992	**1 993**	**Total**
New York, NY	177 789	162 893	340 682
Prince William Sound, AK	2 217	2 400	4 617
Houston/Galveston, TX	176 277	179 912	356 189
Puget Sound, WA	258 666	272 392	531 058
San Francisco, CA	90 289	87 419	177 708
Berwick Bay, LA	88 739	103 897	192 636
St. Mary's River, MI	49 769	33 750	83 519
Totals	843 746	842 663	1 686 409
Average		70 267/month	

Source: Federal Radionavigation Plan 1994, p. 3-42

Present & Future Infrastructure

The Coast Guard is responsible for promoting safe and efficient passage of marine and air traffic by providing continuous and accurate, all-weather radionavigation service. A system of short- and long-range aids to navigation such as buoys and land based aids, including lighthouses and racons, which assist mariners in determining their position in relation to land and hidden dangers, are operated and maintained by Coast Guard. There are 50 600 federal and 48 000 private aids to navigation.

Vessel Traffic Services (VTS), consisting of seven centres - (services are provided out of an eight centre but only temporarily during certain stages of high water) operating around the clock, seven days a week regulates vessel traffic, provides advice and direction to mariners and screens vessels entering United States waters for defects/deficiencies. Initiatives are underway to upgrade and improve equipment at existing Vessel Traffic Centres (VTC). New surveillance techniques and equipment as well as enhanced displays are areas the USCG is emphasizing to improve service to the public.

The future infrastructure will be based on:

- A limited system of buoys and land based aids, including lighthouses and racons;

- A DGPS system providing coverage on all coasts of the continental U.S., parts of Alaska and Hawaii, and the Great Lakes - 50 operational stations are to be implemented by the end of 1996;

- An expansion of the VTS - a study examined 23 potential sites and will form the basis for establishing new VTS systems nationwide; and

- Potentially an Automatic Identification system (AIS) for vessel traffic management.

Highlights of Current SN&C Work

Current efforts are focussed on achieving full operational capability of the DGPS, investigation into AIS and ECDIS, and development of ENC data to meet IMO and IHO standards.

SN&C Implementation Plans

The United States will continue with its adoption and use of SN&C technologies. In particular activities include:

- Completing implementation of DGPS in 1996.

- Continue with expansion of Vessel Traffic Services including establishment on new VTCs.

- Continuing production of CHS charts in digital format.

- Continue work on the development and implementation of ECDIS.

- Continue investigation of AIS as a candidate for vessel traffic management.

Level of SN&C Implementation (High, Medium, Low)

The United States was assessed to have a high level of implementation. The economy is providing DGPS service at harbours and in the Great Lakes (in cooperation with Canada) and will have its system fully operational by the end of 1996. The economy has been involved in trials of ECDIS and is actively digitizing its charts to international standards. Vessel traffic services are currently provided at eight ports with the potential for implementation at another 23 sites. Several initiatives are underway to improve and upgrade equipment at Vessel Traffic Service (VTS) sites including AIS.

Issues Identified

No information was available from the economy on the transition issues to SN&C that are considered to be key ones.

Potential Actions Identified

No information was available from the economy on the transition issues to SN&C that are considered to be key ones.

Data Sources

A variety of data collection techniques were used to obtain the information presented in this report including literature searches, interviews, and surveys. Specific information sources include:

- For the general description and trade data, World Factbook 1995 as presented on the web site "www.odci.gov/cia/publications/95fact/us.html was used.

- The following documentation on the United States aviation sector has been collected:
  - FAA's Plan for Transition to GPS-Based Navigation and Landing Guidance, July 1996.
  - The FAA's web site "www.faa.gov/ats".
  - Federal Radio Navigation Plan, 1994.
  - Final Report of RTCA Task Force 3: Free Flight Implementation, October 1995.
  - "Chicago-Hong Kong: First Direct FANS-1 Flight", Aviation Week & Space Technology, August 12, 1996.
  - Response to SN&C Project Request for Possible APEC action from the Asia Pacific, Europe, Africa and Middle East Division, FAA

- The following documentation on the United States marine sector was collected:
  - USCG web site "www.dot.gov/dotinfo/uscg".
  - Federal Radio Navigation Plan, 1994.

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Appendix F

Acronyms

A	
ACARS	Aircraft Communications Addressing and Reporting System
AEEC	Airlines Electronic Engineering Committee
ADS	Automatic Dependent Surveillance
AIS	Automatic Identification System
APANPIRG	Asia/Pacific Air Navigation Planning and Implementation Regional Group
APEC	Asia-Pacific Economic Cooperation
ATC	Air Traffic Control
ATN	Aeronautical Telecommunications Network
C	
CHS	Canadian Hydrographic Service
CNS/ATM	Communication, Navigation, Surveillance/Air Traffic Management
CPDLC	Controller-Pilot Data Link Communications
D	
DGPS	Differential GPS
E	
ECDIS	Electronic Chart Display Information System
ENC	Electronic Navigation Chart
EPIRB	Emergency Position Indicating Radio Beacon
F	
FAA	Federal Aviation Administration
G	
GES	Ground Earth Station
GLONASS	Global Navigation Satellite System (Russian Federation)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System

H

HO	Hydrographic Office

I

ICAO	International Civil Aviation Organization
IHO	International Hydrographic Organization
IMO	International Maritime Organization
INMARSAT	International Maritime Satellite Organization
ISPACG	Informal South Pacific ATS Coordinating Group

L

LAAS	Local Area Augmentation System
LNG	Liquid Natural Gas

M

MTSAT	Multi-functional Transport Satellite

P

POR	Pacific Ocean Range

R

RAS	Regional Augmentation System
RCC	Rescue Coordination Centre
RENC	Regional ENC Coordination Centre

S

SARPS	Standards And Recommended Practices
SN&C	Satellite Navigation and Communication
SOLAS	Safety Of Life At Sea

T

TPT/WG	Transportation Working Group

W

WAAS	Wide Area Augmentation System
WEND	Worldwide ENC Database
WGS-84	World Geodetic Reference System 1984