Consultation on this draft Plan

This draft National Airspace and Air Navigation Plan sets out the proposed pathway for the modernisation of New Zealand's airspace and air navigation system over the next decade. It outlines the practical steps we all need to take to transition to next generation technologies, manage airspace as demand increases, and to enhance safety and improve the efficiency of New Zealand's airspace.

Some of the changes proposed in the draft Plan are significant. They may require you to install new aircraft equipment, develop new procedures and undergo training.

We are interested in your views on the draft Plan by 3 February 2014:

Do you support the proposals in the draft Plan (and why)?
Are there any proposals in the draft Plan you do not support (and why)?
Is there anything that we have missed that you think should be addressed?

Consultation Workshops

To help you to understand the proposals in the draft Plan, and to give you an opportunity to provide us with direct feedback, workshops will be held across New Zealand from 18 to 22 Nov 2013. You will need to register your attendance, email: consultation@caa.govt.nz.

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Other useful documents

Frequently Asked Questions (FAQs)

Advisory Circular AC91-21 Performance Based Navigation (PBN) - Operational Approvals - This document provides more detail on the proposed PBN elements of the draft Plan. Comments are also welcome during the consultation process.

You can also find out more at the CAA website http://www.caa.govt.nz/naanp/naanp_home.htm

Feedback

Feedback on the proposals in the draft Plan should be provided to the Civil Aviation Authority by close of business on Monday, 03 Feb 2014.

Email: consultation@caa.govt.nz

Post:
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Civil Aviation Authority
PO Box 3555
Wellington 6140
New Zealand
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<td>Advisory Circular</td>
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<tr>
<td>ACARS</td>
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<td>ACAS</td>
<td>Airborne collision avoidance systems</td>
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<td>ACDM</td>
<td>Airport collaborative decision making</td>
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<td>Airline control operation</td>
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<td>Automatic dependent surveillance broadcast</td>
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<td>AeroMACS</td>
<td>Aerodrome mobile airport communication system</td>
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<td>Aeronautical message handling system</td>
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<td>Global navigation satellite systems</td>
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<td>International Civil Aviation Organisation</td>
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<td>Instrument flight rules</td>
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<td>Instrument landing systems</td>
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<td>Multilateration</td>
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<td>MSSR</td>
<td>Mono-pulse secondary surveillance radar</td>
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<td>NOTAMS</td>
<td>Notices to airmen</td>
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<td>OCA</td>
<td>Oceanic control area</td>
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<td>PBN</td>
<td>Performance based navigation</td>
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<td>Receiver autonomous integrity monitoring</td>
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<td>Remotely piloted aircraft</td>
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<td>Satellite communications</td>
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<td>Satellite based augmentation systems</td>
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<td>Single European Sky ATM Research</td>
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<td>SSR</td>
<td>Secondary surveillance radar</td>
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<td>Standard arrival routes</td>
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<td>Safety and efficiency of surface operations</td>
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<td>System wide information management</td>
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<td>Terminal control area</td>
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<td>Visual flight rules</td>
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<td>Very high frequency</td>
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<td>VNAV</td>
<td>Vertical guidance navigation</td>
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<td>VOIP</td>
<td>Voice over internet protocol</td>
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<td>VOR</td>
<td>VHF omnidirectional radio range</td>
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Summary

Introduction
In recent years there have been significant technological advances in airspace management and air navigation services. Satellite navigation now allows aircraft positions to be pinpointed to within a few metres, radar networks can be replaced by aircraft based surveillance systems, digital and satellite communication is developing, information is being digitalised and integrated and air traffic control systems now allow more predictive aircraft management.

This ‘modernisation’ of the airspace and air navigation system will improve the efficiency of air traffic movements, allow more accurate navigation, reduce reliance on ground-based systems, improve communications and increase availability of information for more effective decision-making. These changes will result in reduced operating costs and improved aviation safety.

There is a worldwide drive, led by the International Civil Aviation Organisation (ICAO) to update the aviation system with these new technologies, and move towards an integrated and interoperable global air navigation system. ICAO has produced a Global Air Navigation Plan to guide states in their transition to the new technology. Many individual countries are moving ahead with their own plans, including the United States Next-Gen programme and the Single European Sky ATM Research (SESAR) multinational project for European airspace.

The draft National Airspace and Air Navigation Plan
In line with international efforts, this draft National Airspace and Air Navigation Plan has been prepared to provide clear direction on the safe, cohesive, efficient and collaborative management of New Zealand’s airspace and air navigation system over the next decade. It sets out the practical steps that need to be taken by all participants in New Zealand’s aviation system to transition to the new technologies, and to effectively manage airspace as demand increases and technology advances. It has been developed as a key document under the National Airspace Policy of New Zealand (2012) and will be regularly reviewed.

The draft Plan is a guidance document so it is non-binding. Future policy and regulatory development flowing from the Plan will still go through full analytical and consultation processes. However, the level of detail contained within the plan is intended to provide industry with enough information about future expectations to make investment decisions with reasonable confidence.

Key Proposals
The draft Plan comprises 8 chapters, covering Air Navigation, Surveillance, Communications, Aeronautical Information, Air Traffic Management, Airspace Design, Aerodromes and Meteorological Services. Proposed actions contained in the draft Plan are spread across three stages, 2015, 2018 and 2023. The key proposals contained in each area are summarised below.

Air Navigation - Ground Based to Performance Based Navigation (PBN)
Traditionally air navigation has relied on ground based navigation aids to assist aircraft to fly safety during instrument (IFR) flights. The major change in air navigation over the next 10 years will be the progressive transition worldwide to performance based navigation (PBN) routes and departure and arrival procedures. PBN involves area navigation procedures based on global navigation satellite systems (GNSS) which are more accurate and allow for shorter, more direct routes.

To make a safe transition to the new PBN environment operators will need to ensure that the equipment, procedures and training meets acceptable standards. These are set out in Advisory Circular AC91-21, which is also open for consultation.

The draft Plan signals that a policy on whether New Zealand can introduce ‘sole-means’ GNSS navigation will be completed by end 2015. Further investigation has also signalled the viability of Satellite Based Augmentation Systems for New Zealand.

Air Navigation Key Proposals
- Progressively greater reliance on PBN aiming for a full PBN environment
- A ground navigation aid contingency strategy to ensure adequate ground based navigation aids remain
- Equipment, operator and training requirements for operators wishing to use PBN detailed in Advisory Circulars e.g. AC 91-21.
- Supporting regulatory changes
- Guidance, education and training standards developed for both operators and air traffic controllers to make the transition to PBN
- Further investigation into options for sole means use of GNSS for New Zealand and Satellite Based Augmentation Systems
**Surveillance: Reducing our Reliance on Radar**

By 2021 New Zealand’s primary and secondary radar network will reach the end of its life and will largely be replaced by Automatic Dependent Surveillance-Broadcast (ADS-B) technology as the primary method of air traffic control surveillance.

Mode S 1090 extended squitter transponders will need to be installed in aircraft that fly in controlled airspace – by 2018 for aircraft flying above flight level 24,500 feet (FL 245), and by 2021 for all aircraft flying in remaining controlled airspace. This will provide controllers with exact information about the position, identity and trajectory of aircraft, improving the safety of the system. It follows moves around the world to upgrade to this new technology – e.g. Australia and European Union by 2017 and United States by 2020.

Complete removal of the existing ground based network is not envisaged as this would result in too much reliance on the satellite system – especially with performance based navigation also becoming heavily reliant on GNSS. A contingency strategy to ensure appropriate surveillance back-up will be developed to ensure that in case of system failure, all airborne aircraft can be recovered safely.

**Surveillance Key Proposals**

- Develop a strategy for decommissioning the radar network by 2021, ensuring that an adequate back-up surveillance network remains in place.
- Require ADS-B equipment to be installed on aircraft in a staged way:
  - From 2018: ADS-B carriage mandatory above FL 245
  - From 2021: ADS-B carriage mandatory in all controlled airspace.
- Implement an education programme for operators, pilots and air traffic controllers on ADS-B installation and operational requirements.
- Regulatory changes to allow implementation of ADS-B mandatory airspace and to set ADS-B avionics equipment standards.

**Communications: Incremental Improvements**

Aviation communications have been dominated by radio since the middle of last century. Some countries are considering introduction of domestic data-link (digital messaging) in remote airspace. However New Zealand’s radio coverage and traffic volumes will not justify moves in this direction for some time. On-going maintenance of the very high frequency (VHF) radio network is therefore a key element of this draft Plan.

A number of complementary communications technologies will be explored further over the coming years. Data-link (digital messaging) technology will be extended to some ground communications and the technology as a whole will be reviewed in the future. SATVOICE (satellite phone) technology is already installed in many aircraft, and the Plan enables this technology to be developed as a primary means of voice communication in oceanic airspace. Voice over IP (VOIP) will also be introduced to enable linking to remote sites and for ground communication. Internet Protocol is being developed for airborne aviation but is not anticipated to be viable until after 2016.

Exchange of messages and digital data between aviation users will be made more efficient through the transition to the Aeronautical Message Handling System (AMHS) and ultimately to the Aeronautical Telecommunications Network (ATN).

A key challenge in the future is communications with Remotely Piloted Aircraft. The longer term Remotely Piloted Aircraft policy project will need to include communications requirements to enable these aircraft to integrate into the system.

**Communications Key Proposals**

- VHF voice continues as the primary communication medium in the domestic environment.
- Accept SATVOICE as a primary communication medium in remote oceanic areas.
- Develop new protocols for ground communications – ATN and VOIP.
- International Pre-departure clearances via data-link from 2014.
- Longer term: Review demand for data-link in the domestic environment.
- Implement Communications policy for Remotely Piloted Aircraft.
Aeronautical Information Management: Digital and Integrated

The Aeronautical Information Service is still largely based on a suite of paper-based publications and charts with some online accessibility of information.

Over the next 10 years, the aviation system will become more responsive to demand, with the development of airborne navigation technology, surveillance systems and direct ground-air data-links.

To accommodate this, paper based systems will need to progress to digital data-driven systems that allow continuous, up-to-date and real-time transfer of the full range of aeronautical information to all participants in the aviation system.

New Zealand is well advanced in moving towards digitalisation and integration of its aeronautical information products. More work is yet to be done in the areas of electronic charts, interoperability with meteorological products and the proliferation of devices which can now be used to access data. Care will need to be taken to ensure that human factors associated with data accessibility do not introduce new risks into the system.

Air Traffic Management: From Controlling to Enabling

Central to all of the new technologies explored in this Plan is the presence of air traffic control – the current single coordination point for all air and ground operations.

The modern vision for the Air Traffic Management (ATM) system is based on the provision of services with a view to becoming air traffic-enabling rather than air traffic controlling.

New Zealand’s small aviation system means that our Air Traffic Management system is already reasonably well integrated. However on-going improvements to modern air traffic management tools, combined with the new surveillance, information and navigation technologies will ensure even more efficient flow management and conflict detection – reducing operator costs and improving safety.

Changes in the system lead to the need to ensure that contingency planning is up to date, and all participants in the system are trained and aware of the new environment.

Aeronautical Information Management: Key Proposals

- Complete digitalization of information including completion of the aeronautical information conceptual model, aerodrome and obstacle mapping and electronic aeronautical charts
- Ensure information management is integrated - including interoperability with meteorological products
- Aim for new digital aeronautical data to be accessible real-time to all participants in the system – on the ground and in the air
- Manage human factors associated with accessibility of data – including through the use of new applications and devices

Air Traffic Management: Key Proposals

- Further develop and implement tools to move from the concept of tactical control to strategic control and enabling service provision, for all ground and airborne elements of Air Traffic Management – including:
  - synchronised network management
  - trajectory-based management
  - conformance monitoring
  - Conflict detection using trajectory prediction and conformance monitoring technology
- Ensure adequate contingency planning to enable management during failures in the Air Traffic Management System
- Educate, train and encourage all users (controllers and operators) to operate safely within the changing environment
- Develop a performance framework provide a measure of performance
Airspace Design: Review and Refine

The changes outlined in other parts of this draft Plan signal the need for New Zealand’s Airspace design and designations to be reviewed to accommodate increasing traffic, new types of aircraft and more direct and efficient flight paths.

For example, new performance based navigation routes change flight paths and may remove the need for certain airspace to continue being controlled. New Zealand is also likely to see an expansion in remotely piloted aircraft and the space industry, including more rocket launch sites.

To accommodate these changes, airspace reviews will become more demand driven – so clear triggers and methodologies will need to be developed in a consultative and inclusive way so that user needs are accommodated.

As with any change, adjustments to airspace design introduce safety risk – training and information will need to be provided.

In the longer term, with the introduction of ADS-B surveillance introducing possibilities for comprehensive coverage, the draft Plan signals a further review of transponder requirements in uncontrolled airspace as well as a review of the regulatory requirements around airspace use during aircraft and civil emergencies.

Airspace Design: Key Proposals

- Review existing designations to determine what changes or additions may be necessary
- Airspace reviews to become more demand driven and consultative. Develop triggers and methodology for airspace reviews to take into account milestones and significant changes in activity
- Disseminate information and training to operators about the changed routes and airspace structures
- Reassess provisions relating to transponder requirements – including an assessment of whether uncontrolled airspace should be transponder mandatory
- Consider what variations to airspace rules and procedures could be applicable to cover aircraft emergencies and civil emergencies.

Aerodromes: Increasing Capacity

Aerodrome infrastructure capability can be a limiting factor when attempting to improve traffic flows and improve system capacity.

This increasing pressure on aerodrome’s infrastructure means that airport management should be driven by a collaborative process of master planning, linking in with both airspace management requirements and land management planning to ensure a seamless service for passengers and operators.

Key challenges facing aerodrome management in the future include the need to plan for critical aerodrome infrastructure to ensure that there is sufficient movement area capacity at New Zealand’s aerodromes. Communication between aerodromes and the air traffic control system also needs to be coordinated, particularly to enable efficient management during localised weather and civil emergency events.

Linkages with land use planning remains an important part of any future aerodrome management. Close connection with resource planning processes is important to ensure that the needs of both operators and the public are effectively addressed.

Aerodromes: Key Proposals

- Master plans for aerodromes should have regard to the draft Plan
- Review terminal and airfield design/geometry at critical airports
- Policy developed on airport infrastructure needs for New Zealand
- Establish a formalised airport collaborative decision making forum
- Review critical infrastructure and systems to identify potential areas where further contingency measures are required
**Meteorological Services: Integrating Weather Data**

Full integration of meteorological information into air traffic management (ATM) and performance-based navigation (PBN) applications will be an essential enabler for a future interoperable, seamless ATM system.

Core to this is the development of a weather information exchange model (WXXM) that will provide a common format for weather data and enable integration with aeronautical information systems.

Integration of weather data with other systems will enable real-time weather information to be provided directly to users, including into cockpit.

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**Meteorological Services: Key Proposals**

- Develop WXXM format for weather data
- Aim to integrate weather data with aeronautical information systems
- Aim for real-time weather information to air traffic controllers and into cockpit
A CHANGING AVIATION SYSTEM

Growth in aviation has been exponential since the 1970s with increased social mobility and burgeoning international trade and tourism. Pressure is building to provide greater capacity and efficiency within the aviation system to serve this growth.

Technological shifts

A significant shift in aviation technology is also underway. In the last 20 years, developments in many fields are opening the door to new opportunities for efficiency and safety improvement:

- Global navigation satellite systems can now pinpoint aircraft to within a few metres
- Air traffic service surveillance is moving from ground-based radar to aircraft-based systems
- Digital messaging and satellite communications is supplementing radio transmissions in communications
- Information technologies are allowing us to integrate all aviation data to provide more complete information to pilots
- More powerful computers are enabling the introduction of complex predictive trajectory management

Ongoing ‘modernisation’ of the aviation system will assist in the safe and efficient movement of air traffic, more accurate navigation, reduced reliance on ground-based systems and increased availability of information for more effective decision-making.

These new systems also allow for shorter, more direct routes between two given points as well as more efficient departure and arrival flight paths. This reduces fuel burn, aircraft emissions, and facilitates the movement of air traffic.

However, unmanaged technological changes can also lead to increased safety risks when they outpace the regulatory and infrastructure developments needed to support it.

International harmonisation

There is a strong international drive for an integrated and interoperable global air navigation system, led by the International Civil Aviation Organisation (ICAO) with State and industry support. Alignment to the extent possible with international requirements is important to ensure that New Zealand maintains compatibility and interoperability with the international civil aviation system.

ICAO’s 4th Global Air Navigation Plan (ICAO Doc 9750), outlines the expected availability of new technologies as Aviation System Block Upgrade (ASBU) modules with 4 five-year time increments starting in 2013 (Block 0) and continuing through 2028 and beyond (Block 3).

The ICAO Plan is not mandatory but provides a planning tool for States supporting a harmonized global Air Navigation system. Where States determine a need for the modernisation of their airspace and air navigation systems it is recommended they will follow the applicable modules set out in the ICAO Plan.

The Asia Pacific region has also developed a regional plan to guide states in development and ensure regional harmonization. The ICAO Asia Pacific Seamless Air Traffic Management Plan has been taken into account to ensure this Plan aligns with identified regional outcomes.

Many states are in the process of developing their own plans to take advantage of the changing technologies to improve traffic flow, efficiency safety and environmental performance.

These plans include the ‘NextGen’ programme in the United States and the Single European Sky Air Traffic Management Research (SESAR) multinational project for European airspace. Many countries and regions, including Australia, Canada and the United Kingdom are also well on their way to implementing their own plans.

THE NATIONAL AIRSPACE POLICY

New Zealand has made good progress in the development of policies to take advantage of aviation growth, technological changes and the international drive for harmonisation. In April 2012, the Government issued the National Airspace Policy Statement (see box 1).

The Policy provides overarching principles and desirable attributes that will guide regulators and industry in the development and modernization of the airspace and air navigation system over the next decade.
BOX 1: THE NATIONAL AIRSPACE POLICY

New Zealand’s National Airspace Policy seeks "a safe and capable airspace and air navigation system both within New Zealand and the international airspace it manages, that measures up to international safety standards and best practices, and contributes to economic growth through efficiency gains."

It sets out four principles for the future administration of New Zealand’s airspace by the Civil Aviation Authority:

- **Safety** – that New Zealand’s airspace will be managed holistically with safety as the principal objective.
- **Compatibility** – that New Zealand’s airspace classification and air traffic services shall be compatible with international standards or best practice; and that New Zealand will manage international airspace assigned to it by the International Civil Aviation Organization consistent with international standards and best practice.
- **Protection of National Interests** – the Civil Aviation Authority will continue to be able to designate areas of restricted airspace for military purposes, national emergencies, search and rescue operations, and in any other situation where it is deemed necessary in the interests of safety. Under normal circumstances, the New Zealand Defence Force is expected to have regard to the Civil Aviation Authority’s designation of airspace in its operations, but under exceptional circumstances it will be able to operate freely and without restriction in any New Zealand airspace.
- **Accessibility** – except where restrictions on airspace access are necessary for safety, operational, or other reasons, all aircraft will be able to access such classes of airspace that the aircraft and crew are able to operate safely within.

It also identifies two principles relating to the future provision of Air traffic management and air navigation services (currently the Airways Corporation is the sole provider, but aerodrome air traffic services are contestable):

- **Funding** – the cost of providing services will continue to be recovered on a commercial basis with regard to legislation and, where appropriate, charging guidelines issued by the International Civil Aviation Organization.
- **Resilience** – the supporting systems and infrastructure will ensure that any disruption to the network as a result of natural disasters or interference is mitigated to the extent possible.

The policy also sets out a number of other desired attributes of New Zealand’s future airspace and air navigation system, which will be pursued as much as possible without compromising safety:

- **Efficient** – the air navigation system and the design and classification of airspace will facilitate the efficient operation of aircraft within New Zealand airspace.
- **Environmentally responsible** – the future airspace and air navigation system will be respectful of the impacts of aviation on the environment, and any development that can reduce the overall environmental impact of aviation will be pursued as long as it can be achieved safely and at reasonable cost.
- **Integrated** – the aviation sector and local authorities will proactively address their respective interests in any future planning to facilitate the adoption of more efficient aircraft arrival and departure paths in a timely way and to avoid or mitigate incompatible land uses or activities and potential impacts or hazards that will impact, or have the potential to impact on the safe and efficient operation of aircraft.
- **Interoperable** – the National Airspace and Air Navigation Plan will be compatible with other global and regional plans, including the International Civil Aviation Organization’s Global Air Navigation Plan, as much as practicable while taking into account any unique aspects of airspace and air traffic management in New Zealand.
THE NATIONAL AIRSPACE AND AIR NAVIGATION PLAN

This National Airspace and Air Navigation Plan is guided by the principles and desirable attributes set out in the National Airspace Policy as well as the international direction set by ICAO. It is one of the five key Government actions for aviation set out in ‘Connecting New Zealand – A Summary of the Government’s Policy Direction for Transport’ (2011).

The Plan is a guidance document so it is non-binding. Future policy and regulatory development flowing from the objectives, principles and actions in the plan will still go through full analytical and consultation processes. However, the level of detail contained within the plan is intended to provide industry with enough information about future expectations to make investment decisions with reasonable confidence.

Plan Objectives

The Plan’s key objective is: To provide clear direction on the safe, cohesive, efficient and collaborative management of New Zealand’s airspace and air navigation system over the next decade

To achieve this it will:

- Phase in new systems and technologies in a systematic and orderly manner
- Identify and mitigate the risks associated with technology and process change
- Ensure that there are adequate contingencies in the event of system failure
- Address human factors issues associated with changing systems
- Align as far as possible with international standards and practices, particularly ICAO and Asia-Pacific regional requirements
- Provide directions for system-wide coordination of all aspects of our airspace management system
- Encourage linkages across regulatory regimes to ensure integration with respect to environmental management including land use
- Be technology enabling rather than technology driven
- Optimise the efficiency of passenger transport
- Ensure that ongoing service will be provided to operators with compliant equipage
- Be practical and achievable
- Encourage collaborative mechanisms to address different needs of aviation system users and the public in airspace management
- Encourage early uptake of the technology

Plan Elements

The Plan is broken down into the eight elements of New Zealand’s airspace system:

- **Navigation**: the ability of pilots to determine their position and accurately follow a defined flight path
- **Surveillance**: the ability of air traffic services to identify an aircraft’s position and trajectory
- **Communications**: the systems for transferring information between participants in the system
- **Aeronautical Information Management**: the provision of aeronautical information such as charts and publications to operators
- **Air Traffic Management**: the provision of air traffic services, airspace management and air traffic flow management to ensure safety and optimise capacity
- **Airspace Design**: the classification and the designation of different types of airspace for various aviation system uses
- **Aerodromes**: the provision of infrastructure and services that meet the needs of aerodrome users and communities
- **Meteorological Services**: the provision of meteorological information and forecasts

Each element contains a series of actions phased across 3 stages – 2015, 2018 and 2023. There are also details on possible items for phasing after 2023 in line with ICAO timeframes.

The actions identified in the Plan have been developed taking the following into account:

- Aircraft equipment requirements
- Infrastructure development
- Contingency and emergency systems
- Procedures and management tools
- Education and training requirements
- Information requirements
- Associated regulatory changes

Ongoing Review

This plan will be a living document, with regular reviews to coincide with the key stages set out on the plan – 2018 and 2023.

This does not preclude reviews of the Plan in the intervening years should new technological or international developments warrant the need.

Performance measures will be based on an assessment of whether the Plan’s objectives have been achieved, and whether the actions contained within the Plan have been delivered.
Air Navigation – Ground-based to Performance-Based Navigation

INTRODUCTION
Air navigation is the process of planning, directing, and monitoring the movement of an aircraft from one place to another.

In the early days of flight, aircraft were navigated visually by dead reckoning - identifying geographical points with the aid of maps and compasses. Reasonable weather conditions were needed so that pilots could keep the ground in sight.

After the Second World War, new technologies were introduced to enable pilots to find their way without the need for visual reference. New types of ground based navigation aids (such as NDB, VOR/DME and ILS – see box 2) were installed that allowed aircraft to navigate along fixed routes and to conduct instrument approach and departures from aerodromes.

The early 1980s heralded the development of Global Navigation Satellite Systems (GNSS) – a network of orbiting satellites which when combined provided total global coverage. The most well-known GNSS system is the United States’ Global Positioning System (GPS). The Russians also have a system called GLONASS. China and the EU are also developing systems which are expected to be operational by 2020.

The new GNSS systems are unconstrained by the location, accuracy and terrain limitations associated with ground navigation aids and have allowed more precise aviation navigation. Aircraft equipped with GNSS receivers can identify their positions accurately, at all points along their route – introducing a new level of flexibility and accuracy into aircraft navigation.

However, this new system relies heavily on the performance of the GNSS receivers on board the aircraft. There is a wide range of products available on the market today, and many of these do not have the accuracy, integrity, continuity and functionality required to ensure the safety of the flight. The reliability of the satellite networks is also critical to the success of the new system.

Performance Based Navigation
Performance specifications are therefore needed to ensure that the receiving equipment on board the aircraft meets the appropriate standards. This has given rise to the term Performance Based Navigation (PBN).

PBN involves use of satellite-based navigation aids and area navigation procedures which are more accurate and allow for shorter, more direct flights.

In the future, Performance Based Navigation based on GNSS will become the primary method for flights operating under instrument flight rules (IFR).

There are two types of navigation performance specifications in Performance Based Navigation:

- **RNAV (aRea NAVigation)** A method of navigation which permits aircraft operation on any desired flight path within the coverage of ground or space-based navigation aids or within the limits of the capability of self-contained aids, or a combination of these.\(^1\)

- **RNP (Required Navigation Performance)** allows an aircraft to fly a specific path between two 3-dimensionally defined points in space. The key difference between RNAV and RNP is that RNP requires on-board performance monitoring and alerting so that the pilot is notified early of any reduced satellite coverage and is therefore a more robust system. For example, GNSS with Receiver Autonomous Integrity Monitoring (RAIM) meets the required standards.

RNAV instrument approach procedures can be augmented with lateral and vertical guidance - called approach procedures with vertical guidance (APV). These do not meet the requirements established for precision approach and landing operations.

**BOX 2: NAVIGATION DEFINITIONS**

**VOR:** VHF Omnidirectional Radio Range: A ground based radio transmitter that sends out 360 degree directional radio signals to guide aircraft

**NDB:** A ground based radio transmitter at a known location. Its signal does not include inherent directional information, in contrast to VOR

**DME:** Distance measuring equipment on board aircraft that allows the pilot to measure the distance to a ground based navigation station

**DME/DME:** Aircraft can take position fixes from two ground stations to determine position. DME/DME/IRU is similar but the aircraft uses an on-board inertial reference unit to monitor progress when DME coverage is interrupted

**ILS:** Instrument landing system – an antenna array based at the airport that guides aircraft in to land

**APV:** Approach with vertical guidance – uses either SBAS (Satellite Based Augmentation Systems) or Baro (VNAV) systems to enable approaches with greater vertical precision. The former requires a network of ground based reference stations and a geostationary satellite to transmit correction data to the aircraft GNSS, while the latter requires special equipment on board aircraft to calculate the correction factors

\(^1\) Area navigation includes performance-based navigation as well as other RNAV operations that do not meet the definition of performance-based navigation.
INTERNATIONAL DEVELOPMENTS
The move to Performance Based Navigation was signalled in 2007 with a resolution of the Assembly of the International Civil Aviation Organization (ICAO) calling on member States to complete an implementation plan for Performance Based Navigation by the end of 2009. In summary, State plans should achieve:

- implementation of RNAV and RNP operations (where required) for en-route and terminal areas according to established timelines and intermediate milestones
- implementation of approach procedures with vertical guidance (APV) (Baro-VNAV and/or augmented GNSS - SBAS), including LNAV (lateral guidance only) minima, for all instrument runway ends, either as the primary approach or as a back-up for precision approaches by 2016 with intermediate milestones as follows: 30 per cent by 2010, 70 per cent by 2014
- implementation of straight-in LNAV (lateral guidance only) procedures at aerodromes where VNAV (vertical guidance) is technically not possible, or where there is no local altimeter setting available and where there are no aircraft suitably equipped for APV operations with a maximum certificated take-off mass of 5,700 kg or more

It also urged that States include provisions in their PBN implementation plan for creation of approach procedures with vertical guidance (APV) to all runway ends serving aircraft with a maximum certificated take-off mass of 5,700 kg or more, according to established timelines and intermediate milestones.

ICAO developed a set of specifications to guide States in the development of their own plans (see figure 1), and provided guidance material on implementation in the PBN Manual (Doc 9613).

A significant amount of international effort is going into improving the accuracy and reliability of satellite navigation systems. ICAO notes that the United States GPS system will provide signals on two frequencies by 2018. New satellite constellations from Europe (Galileo) and China (Bediou) are coming online in the next 5 years. The availability of multiple frequencies could reduce ionospheric errors. This will allow further increase in accuracy from 2018 and beyond.

Performance based navigation implementation is well down the track in many countries, for example:

- Australia has over 500 PBN approach procedures with plans to add LNAV/VNAV. Australia has also completed a Ground Landing System Category 1 trial at Sydney.
- The United States has over 5000 PBN approaches, with almost 2500 having LNAV/VNAV and LPV minima (based on its version of SBAS, the Wide Area Augmentation System WAAS). Of the procedures with LPV minima, almost 500 allow the aircraft to approach with 200 ft cloud base.

FIGURE 1: ICAO SPECIFICATIONS FOR PERFORMANCE BASED NAVIGATION

<table>
<thead>
<tr>
<th>Designation</th>
<th>RNAV specifications</th>
<th>Designation</th>
<th>RNP specifications</th>
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<tbody>
<tr>
<td>RNP 4</td>
<td>(No requirement for on board performance monitoring)</td>
<td>RNP 2</td>
<td>(Includes a requirement for on board performance monitoring and alerting (RAIM))</td>
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<tr>
<td>RNP 2</td>
<td>Oceanic and remote applications</td>
<td>RNP 1</td>
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<td>A-RNP</td>
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<td>A-RNP</td>
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<tr>
<td>RNP APCH</td>
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<td>RNP AR APCH</td>
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<tr>
<td>RNP 0.3</td>
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<td>RNP 0.3</td>
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<tr>
<td>En route and terminal navigation applications</td>
<td></td>
<td>En route and terminal navigation applications</td>
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</table>

The numerical designators define the level of accuracy required of the navigation system, for example RNP 2 should accurately pinpoint the aircraft to within 2 nautical miles, 95% of the time.

The RNP APCH (required navigation performance APproach) specifications require a standard navigation accuracy of 1.0 NM in the initial, intermediate and missed segments and 0.3 NM in the final segment.

The RNAV 10 specification was previously called RNP 10 and is still called RNP 10 in some documents.
TABLE 1: ICAO BLOCK UPGRADES RELATED TO NAVIGATION

<table>
<thead>
<tr>
<th>Block 0</th>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
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</thead>
<tbody>
<tr>
<td>Improved Flexibility and Efficiency in Descent Profiles (CDO)</td>
<td>Deployment of performance-based airspace and arrival procedures that allow the aircraft to fly their optimum aircraft profile taking account of airspace and traffic complexity with continuous descent operations (CDOs).</td>
<td>Deployment of performance-based airspace and arrival procedures that allow the aircraft to fly their optimum aircraft profile taking account of airspace and traffic complexity with Optimised Profile Descents (OPDs).</td>
<td>Deployment of performance-based airspace and arrival procedures that optimise the aircraft profile taking of airspace and traffic complexity including Optimised Profile Descents (OPDs) supported by Trajectory-Based Operations and self-separation.</td>
</tr>
<tr>
<td>Improved Flexibility and Efficiency in Departure Profiles - Continuous Climb Operations (CCO)</td>
<td>Deployment of departure procedures that allow the aircraft to fly their optimum aircraft profile taking account of airspace and traffic complexity with continuous climb operations (CCOs).</td>
<td>Taking advantage of the lowest possible minima through the extension of GNSS approaches from Cat 1 to Cat II and III capability at a limited number of airports. Harness integration of PBN Standard Arrival Routes (STARS) directly to all approaches with vertical guidance - allows for both curved approaches and segmented approaches in an integrated system.</td>
<td></td>
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<tr>
<td>Development of GNSS based approaches (APTA)</td>
<td>Optimisation of Approach procedures including vertical guidance – as the first step towards universal implementation of GNSS approaches – includes GNSS, Baro vertical navigation (Baro VNAV), satellite based augmentation system (SBAS) and ground based augmentation system (GLS)</td>
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CURRENT STATUS OF AVIATION NAVIGATION IN NEW ZEALAND

Navigation in New Zealand has traditionally relied upon a network of ground based navigation aids,\(^2\) that pilots use to navigate along fixed routes (route navigation) and to make instrument approaches and departures at aerodromes.

In 1997 New Zealand was one of the first countries in the world to implement rules to allow instrument flight procedure operations using GPS. However these rules have not been updated to reflect the modern use of GNSS.

PBN implementation progress

In 2009, in response to the ICAO resolution that all states should develop a Performance Based Navigation Implementation Plan, New Zealand published a PBN Implementation Plan. It was one of the first to be produced and was internationally recognised as a model for others.

The agreed concepts for New Zealand are to be implemented through a three-phase process with target implementation dates of 2012, 2017 and 2020. Through this process, all ATS routes (including SIDs and STARs) will be enabled by RNAV (or RNP, where required). All runway ends with instrument approach procedures will be enabled by RNP (with APV where possible based on Baro-VNAV).

The plan adopted the following standards for NZ domestic PBN:

- For en route operations: RNAV 2
- RNAV 1 for all terminal routes with surveillance services and Basic RNP 1 for routes without surveillance services.

For approach operations - RNP APCH The legacy RNAV (GNSS) arrivals, RNAV (GNSS) SIDs, and RNAV (GNSS) approach procedures currently used in New Zealand are as they are reviewed being replaced with the above specifications.

As a result of this early planning, design and implementation of RNAV routes and procedures is well advanced. Existing ground based navigation aids remain in operation and operators currently

\(^2\) Non-Directional Beacons (NDB), Very High Frequency Omnidirectional Radio Range (VOR)/Distance Measuring Equipment (DME), and Instrument Landing Systems (ILS).
have a choice between the old navigation systems and the new performance based navigation procedures in many parts of the country.

Certificated Part 173 Procedure Design organisations have a significant workload in turning the design work into published documents.

The following procedures are already promulgated:

**Routes**

- RNP 10 (RNAV 10)\(^3\) and RNP 4\(^4\) in Auckland Oceanic airspace
- All domestic RNAV ATS routes were designated RNAV 2 in 15 November 2012

**Arrival and departure procedures**

- RNAV(GNSS) approach procedures implemented at most aerodromes to replace or complement existing ground-based instrument procedures
- RNAV (GNSS) arrival and departure procedures (RNP 1 application) at selected regional aerodromes
- Approach with vertical guidance based on Barometric Vertical Navigation (Baro-VNAV) criteria implemented at all international airports
- RNAV Standard Instrument Departure Routes (SIDs) and Standard Arrival Routes (STARs) being implemented at Auckland, Wellington, and Christchurch aerodromes
- RNP AR APCH procedures at selected terrain-challenged locations, e.g. Queenstown and Rotorua

**Regulatory requirements**

The navigation equipment requirement and use standards are specified in Civil Aviation Rule 91.501(2) which states that a “person shall not operate an aircraft unless the instruments and equipment installed in the aircraft comply with [a specified list] or an alternative specification and design standard approved by the Director.”

The acceptable standards for equipment use on PBN routes and approach procedures are currently provided in a revised draft of *Advisory Circular AC 91-21 Rev 1 Performance Based Navigation (Operational Approvals).* It sets out equipment standards, procedural and training requirements for operators wishing to use PBN routes.

Until rule changes can be implemented the Director of Civil Aviation has issued a general exemption from some of the Part 19 Subpart D rules that limit the use of GNSS, provided it is in compliance with the requirements of the Advisory Circular.

**Equipment approvals:** From 1 May 2014 all new equipment installations will need to have approvals (recorded on the aircraft 2129 avionics form).

Existing operators (both private and commercial) wishing to fly published RNAV, RNP and RNP APCH procedures will need to obtain approvals for their existing equipment from 1 November 2014.

The Advisory Circular suggests the following equipment requirements to fly a particular route or approach procedure from October 2014:

- Part 91 operators – 1 GNSS receiver plus one alternate non-GNSS system
- Part 119 Operators – 2 GNSS receivers plus one alternate non-GNSS system

The common standard for GNSS equipment is either a TSO 145/146, or a TSO 129 receiver with or without fault detection.

**Operator approvals:** Operational approval is also required to confirm the adequacy of the operator’s normal and contingency procedures for the particular equipment installation.

- Maintenance procedures (including maintenance of the navigation database)
- Pre-flight planning requirements
- General operating procedures
- Contingency procedures
- Training requirements

**Pilot approvals:** Pilots may conduct PBN operations if they have an appropriate instrument rating for the PBN system and meet the currency requirement.

**Infrastructure developments**

Airways have a PBN implementation Plan for all controlled aerodromes which is being rolled out for completion in 2017 covering instrument procedure design and associated ATC training.

A number of large operators, including Air New Zealand have also developed their own PBN Implementation Plans.

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\(^3\) Distance based separations for RNP10 aircraft and for RNP4 aircraft require surveillance via ADS-C and communications to RCP240 via CPDLC.

\(^4\) In the case of RNP 4, ADS contract (ADS-C) is used.
CHALLENGES FOR NEW ZEALAND

In the future there are a number of challenges that will need to be addressed in the navigation area:

Safety management during transition to PBN environment

The key challenge during this transitional period is to ensure that all safety issues relating to implementation of the new procedures are effectively addressed – in particular that:

Q Operators wishing to use the new routes have the equipment capabilities, operational procedures and training to manage the new routes

Q PBN is effectively implemented into the air traffic management system

Q Navigation databases are accurate, reliable and from an approved provider

Q Weather information supports PBN use

Reliability of the satellite system – Contingency

While there are contingency systems in place during a mixed mode navigation system, a more exclusive PBN environment will mean that there are less alternatives available in the event of a GNSS outage. There is a great deal of work underway internationally to assess the reliability of the satellite system and there may be improvements in this area from about 2018 onwards.

A key challenge for New Zealand will be to ensure that there is an adequate ground based navigation network to provide a safe alternate in the case of a failure of the satellite system.

GNSS system performance and prediction of continued availability of the service needs to be assured.

Upgrade costs and practicality

Aircraft operating in New Zealand airspace currently have a diverse range of navigational capabilities. This diversity coupled with a wide mix of aviation activities, high level of non-commercial operations and older aircraft fleet mean that not all participants will have the level of equipage to meet future requirements and that upgrading costs will vary greatly.

A balance will need to be struck between the needs of the operators who are driving towards an exclusive PBN environment (which will allow best cost savings) and the needs of some participants in the aviation system in particular some in the General Aviation community, for whom cost may outweigh benefits until equipment costs reduce.

In addition, there are some practical implications to take into account – New Zealand only has a small number of avionics engineers experienced with the new technology, and is reliant on supply of equipment from overseas. Time will be needed to allow operators to arrange for upgrades and there may be impacts on the operation of both existing and new aircraft systems.

Changes in environmental impacts

The new routes are expected to have a positive effect on emissions, with less fuel burn and reduced carbon emissions.

Widespread change to air navigation routes, approaches and departures may result in changes to overall noise patterns resulting from more accurate tracks over particular areas. This is most likely to affect areas close to aerodromes with more accurate arrival and departure flight paths.

Outdated regulatory requirements

There are also issues relating to the existing rule set, which has not kept up with the new technologies. For example, a general exemption is currently in place to allow GNSS to be used as the primary means of navigation (Civil Aviation Rule Part 19 currently does not allow this).

Aspects of the Advisory Circular setting out the future regulatory requirements would also benefit from greater clarity in the rules around expectations.

Regulator resourcing

Introduction of processes to approve aircraft systems, operator procedures and implement training requirements will require significant resourcing from the Civil Aviation Authority. Time will be needed to allow for regulatory approvals, and resources will need to be set aside to PBN capability register.
## PLAN FOR NAVIGATION

### Stage 1 (2015): Mixed mode – continued use of legacy navigation applications while PBN capability is progressively implemented in aircraft fleets and the supporting infrastructure. The ground infrastructure associated with legacy navigation systems will be reviewed and progressively adapted.

### Stage 2 (2018): Some exclusive PBN environments: move to a more exclusive PBN environment that places greater reliance on the level of PBN capability in the national fleet and infrastructure. The ATM system will be managing a more homogeneous navigation capability.

### Stage 3 (2021): Full PBN environment, with some system redundancy. A mature set of air traffic management tools will complement the airborne systems and will also enable the effective management of those aircraft that may experience a temporary loss of PBN capability. All ATS routes (including Standard Instrument Departures and Standard Terminal Arrival Routes) will be enabled by RNAV (or RNP, where required). All runway ends with instrument approach procedures will be enabled by RNP (with APV where possible based on Baro-VNAV).

### Objectives

- Implement PBN routes to enable progressively greater dependence on PBN – initially to support key routes for larger operators and ultimately aiming for a sole-means GNSS navigation environment.
- Develop and implement a ground navigation aid strategy. The strategy should be developed consultatively and:
  - Ensure that in case of a GNSS outage, all airborne aircraft can be safely recovered.
  - Ensure continuity of service can be maintained on the main trunk routes.
- Implement a strategy based on the concepts of PBN (includes RNAV and RNP specifications), that will be applied to IFR aircraft operations using instrument approaches, and ATS routes (including SIDs and STARs) in both oceanic and domestic airspace.
- Equipment, Operator and Training requirements for PBN to be implemented as detailed in Advisory Circular AC 91-21.
- Guidance, education and training standards developed for both operators and air traffic controllers to make the transition to a PBN environment.
- Ensure that the policy and regulatory framework supports the changes.
- Complete further analysis on the following areas:
  - Complete technical and policy analysis on implications of sole means GNSS for New Zealand.
  - The need for Satellite Based Augmentation Systems (SBAS).
  - Requirement for GNSS Landing Systems (GLS).
  - Option to transition from single GNSS to multi-constellation GNSS.

### Principles

- Encourage early uptake of the technology.
- Ensure that there is sufficient time allowed for aircraft to be equipped, and operators and pilots and air traffic controllers appropriately skilled in the new modes of navigation.
- Through all stages, a collaborative and participatory approach – between instrument procedure designer organisations, operators, aerodrome operators and affected communities will ensure smooth transition.
- Accommodating mixed-equipage operations until a full PBN environment.
- Implementation of the navigation portion of the CNS/ATM system is capable of supporting the operational airspace concept.
- Equipment requirements minimise the number of equipment types required on board aircraft and on the ground.
## Navigation Actions

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<tbody>
<tr>
<td>Implement PBN routes to enable progressively greater dependence on PBN – initially to support key routes for larger operators and ultimately aiming for a sole-means GNSS navigation environment.</td>
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<tr>
<td>RNAV 10 and RNP 4 in Oceanic airspace. RNAV 2 for routes. RNAV 1 for all terminal routes with surveillance services and basic RNP 1 for routes without surveillance services. At least one ground based instrument approach procedure retained for each main runway end at controlled aerodromes.</td>
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<tr>
<td>RNP 2 in routes above FL 145 RNP APCH (RNAV GNSS) with APV where possible and RNP AR APCH as required. Includes Helicopter routes.</td>
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</tr>
<tr>
<td>All routes (including SIDs and STARs) will be enabled by RNAV (or RNP, where required). All runway ends with instrument approach procedures will be enabled by RNP (with APV where possible based on Baro-VNAV)</td>
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<tr>
<td>Develop and implement a clear strategy to identify which ground navigation aids should remain in place as a contingency in case of emergencies and equipment failures.</td>
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<td>Develop Navigation Aid Contingency Strategy using a consultative process</td>
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<tr>
<td>Decommissioning of some terrestrial navigation systems in accordance with Navigation Aid contingency strategy</td>
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<tr>
<td>Navigation Aid contingency network in place</td>
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<tr>
<td>Equipment, Operator and Training requirements for PBN to be implemented as detailed in Advisory Circular AC 91-21 Rev A</td>
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<tr>
<td>Operators wishing to use promulgated PBN Routes to comply with equipment, procedure and training specifications in Advisory Circular AC91-21.</td>
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<tr>
<td>All IFR operators to be approved for PBN navigation</td>
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<td>Guidance and education for operators to make the transition to a PBN environment</td>
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<tr>
<td>Develop guidance and education programme for affected operators, pilots and air traffic controllers</td>
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<tr>
<td>Implement guidance and education programme</td>
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<tr>
<td>Training standards revised for pilots flying PBN routes</td>
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<tr>
<td>IFR training standards updated</td>
<td></td>
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<tr>
<td>IFR training standards promulgated</td>
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<tr>
<td>Ensure that the policy and regulatory framework supports the changes</td>
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<tr>
<td>Revoke Part 19 GPS rules and replace with new operational rules Complete analysis on “sole use” navigation for domestic IFR flight</td>
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<tr>
<td>Review requirements for Satellite Based Augmentation System</td>
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**Surveillance – Reducing our reliance on Radar**

**INTRODUCTION**

The primary purpose of air traffic control worldwide is to prevent aircraft colliding with each other.

Early en route controllers kept track of the position of aircraft with the help of maps and blackboards. They had no direct radio link with aircraft. Instead, they used telephones to stay in touch with airline dispatchers, airway radio operators, and airport traffic controllers.

The introduction of radar during the Second World War created a step change in aircraft tracking. By the 1960s, radar surveillance of civil aircraft gave air traffic controllers more accurate knowledge of aircraft position, which allowed closer aircraft spacing and greater efficiency.

There are two types of radar:

- **Primary Surveillance Radar. (PSR)** transmits a series of pulses that are reflected by aircraft. The range and bearing of each aircraft detected is presented to the controller. Primary Surveillance Radar cannot identify aircraft, and is also prone to receiving “false” targets e.g. rain, birds, etc.

- **Secondary Surveillance Radar (SSR)** not only detects and measures the range and bearing of aircraft, but also requests additional information from the aircraft itself such as its identity and altitude. Secondary Surveillance Radar relies on aircraft equipped with a transponder; the transponder replies to each interrogation signal by transmitting a response containing encoded data. Transponders are mandatory in controlled airspace in New Zealand.

**Multilateration (MLAT)** is a more recent ground-based surveillance technique. A number of ground stations in strategic locations interrogate and receive replies from aircraft SSR transponders. The time difference of arrival of a reply at four or more ground stations allows the system to calculate the position of the aircraft. Multilateration targets are updated typically once per second, compared with five second intervals for radar targets.

**ADS-B** – Auto Dependent Surveillance Broadcast transponders broadcast an aircraft’s position, altitude, velocity and other aircraft-derived data once or twice per second. This data is received by relatively simple ground stations and is fed to air traffic control displays, providing controllers with richer and more accurate information, which enables more efficient traffic flow and improves safety.

Aircraft equipped with **ADS-B IN** can also receive ADS-B transmissions from other aircraft. ADS-B IN is expected to eventually replace the existing aircraft collision avoidance systems. Trials using ADS-B IN for specific types of self-separation, such as in-trail climb, are being conducted. Self-separation is unlikely to be adopted in New Zealand domestic airspace for many years.

An **ADS-B** system can also be enhanced with graphical weather information overlay from Traffic Information Service Broadcast (TIS-B) and Flight Information Service-Broadcast (FIS-B) applications. It also provides the infrastructure for inexpensive flight tracking, planning, and dispatch.

An aircraft **ADS-B transponder** (which is an advanced secondary surveillance radar transponder) requires an input from a GNSS receiver, either directly or via the flight management system. This arrangement is known as 1090 Extended Squitter (1090 MHz is the transponder transmission frequency) and is the system adopted internationally.

An alternative system employing a Universal Access Transceiver (UAT) is used only in North America and only for aircraft operating below certain levels. While UAT uses simpler technology in the aircraft, it is not compatible with 1090 Extended Squitter. To employ both systems in New Zealand would require both 1090 Extended Squitter and UAT ground equipment at each site; the cost would be prohibitive.

**INTERNATIONAL DEVELOPMENTS**

**ADS-B** will become the main surveillance technology for controlling aircraft worldwide. **ADS-B** is compatible with other surveillance systems such as multilateration.

ICAO advocates the transition to **ADS-B** where ATS surveillance is required. This is reflected in the ICAO Global Navigation Plan (see table2)
TABLE 2: ICAO BLOCK UPGRADES RELATED TO SURVEILLANCE

<table>
<thead>
<tr>
<th>Block 0</th>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ground surveillance (ASUR)</strong></td>
<td>Ground surveillance supported by ADSB-Out and/or Wide Area Multilateration systems will improve safety and capacity through separation reductions</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Improved access to optimum flight levels (OPFL)</strong></td>
<td>Allow climb and descent procedures using ADS-B – prevents aircraft being trapped at a sub-optimal altitude and reduces fuel burn</td>
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<td></td>
</tr>
</tbody>
</table>

A number of other countries have already made progress towards implementation of ADS-B

**United States:** ADS-B is an integral component of the United States Next-Gen National Airspace Strategy for aviation infrastructure and operations. From January 2020, aircraft in controlled airspace where a Mode C transponder is now required will require an FAA-approved ADS-B system.

**Australia:** Deadlines for carriage of ADS-B transponders are:
- 12 December 2013: all aircraft operating at or above FL 290
- 6 February 2014: all newly registered IFR aircraft and any newly registered recreational VFR aircraft operating in controlled airspace.
- 4 February 2016: all IFR aircraft operating in class A, B, C or E airspace around Perth
- 2 February 2017: all IFR aircraft operating in class A, B, C or E airspace
- 1 January 2020 - all VFR aircraft operating in class A, B, C or E airspace

**EU:** In the EU airspace aircraft with a weight above 5,700 kilograms or a maximum cruise speed of over 250 knots will be required to carry ADS-B from 2017 (new aircraft from 2015).

**Canada:** Canada has implemented ADS-B technology in the Hudson Bay area, with estimated savings of $158M in fuel per annum.

**STATUS OF NEW ZEALAND SURVEILLANCE**

In New Zealand, Airways provides radar coverage of most controlled en route and terminal airspace using monopulse Secondary Surveillance Radar (MSSR), with local areas of Primary Surveillance Radar and Multilateration.

5 ADS-C transmits position and intent information in response to a ‘contract’ established by ATC ground.
6 Flight Management Computer Waypoint Reporting. Flight crew send a position report to the Aircraft Operations Centre, who forward it to Air Traffic Control.
CHALLENGES FOR NEW ZEALAND

Given the impending decommissioning of the radar network and the implementation of ADS-B and related technologies, New Zealand will require standards for ADS-B equipment on board aircraft so it too can take advantages of the many benefits that flow from this versatile technology.

Challenges for operators

The introduction of ADS-B technology will benefit both Airways and the larger operators due to improved surveillance coverage, improved traffic flow, reduced fuel costs and reduced infrastructure costs. However, at current prices, the technology may not yet be cost effective for other air transport and private operators.

Installation and equipment availability issues will need to be managed to ensure that there are adequate lead times to enable operators to install and seek approvals for equipment before the radar network is decommissioned. Installation of the new network will require careful testing and trialling to ensure that the system does not introduce safety risks.

Decommissioning the radar network

With the proposed decommissioning of the radar network by 2021, an alternate option will need to be implemented for surveillance. Decommissioning of major infrastructure also presents its own technical challenges, and will need careful management.

Fail-safe systems

While the ADS-B receiver network will enable wider and cheaper coverage than the radar network, ADS-B relies on accurate GNSS position information. A GNSS failure, while extremely unlikely, must be taken into account, and some ground based surveillance may be required as a back-up.

Procedural and training needs

New technology brings with it the need for new procedures and training. Maintenance and operator procedures will need updating while pilots and air traffic controllers will need to be trained.

Changes in regulation

New regulatory requirements will need to provide clarity on equipment, training and procedural requirements, and both the regulator and the industry will need to build capacity and understanding.

Future shifts in technology

In time, ADS-B IN, combined with advances in aircraft collision avoidance systems, may allow for further changes to service concepts, with aircraft able to be more self-managing, and less reliant on air traffic control services. This is unlikely to be practical before 2023 in domestic airspace, but trials using ADS-B IN for self-separation for in-trail climb are being conducted in the Pacific, and might be introduced into the Auckland Oceanic FIR.

Multistatic Primary Surveillance Radar (MPSR) is a developing technology that uses a number of dispersed receivers to detect the reflected signals from very high frequency FM or television broadcast transmissions. The processing of these signals is similar to that employed in Multilateration. MPSR is still under development, with trials underway in Europe and North America. It may offer an economical alternative to the expensive conventional primary surveillance radar.
**PLAN FOR SURVEILLANCE**

**Stage 1 (2015):** Planning for progressive implementation of ADS-B, including rule development and training and education programme development.

**Stage 2 (2018):** ADS-B mandatory airspace above FL 245 with supporting network of ADS-B receivers

**Stage 3 (2023):** ADS-B mandatory in all controlled airspace from 2021 supported by back-up ground surveillance network. Some provision for controlled airspace to be designated for transit lanes and special areas for non-ADS-B equipped aircraft as per contingency plan

**Objectives**

- Install a network of ADS-B ground stations to replace the radar network.
- Develop a strategy for decommissioning the radar network by 2021, ensuring that an adequate back-up surveillance network remains in place. This should be consulted and:
  - Ensure that in case of a GNSS outage, all airborne aircraft can be safely recovered.
  - Ensure continuity of service can be maintained at international airports and on the main trunk routes.
  - Make provision for some controlled airspace to be designated for transit lanes and special areas for non-ADS-B equipped aircraft.
- Require ADS-B equipment to be installed on aircraft in a staged way:
  - From 2018: ADS-B carriage mandatory above FL 245
  - From 2021: ADS-B carriage mandatory in all controlled airspace
  - ADS-B equipment standard: 1090 Mode S Extended Squitter.
- Implement an education programme for operators, pilots and air traffic controllers on ADS-B installation and operational requirements
- Regulatory action to allow implementation of ADS-B mandatory airspace and to set ADS-B avionics equipment standards.

**Principles**

- Allow time for general aviation operators to meet requirements and for equipment prices to reduce.
- All new technology installation meets safety standards that either maintains or improve on existing safety requirements.
- Installation of ADS-B technology aligns with timeline for Performance Based Navigation technology.
## Surveillance Actions

<table>
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<tbody>
<tr>
<td>Planning for progressive implementation of ADS-B</td>
<td>ADS-B mandatory airspace above FL 245 and CTA or major international airports</td>
<td>ADS-B mandatory in all controlled airspace. Back-up ground surveillance network in place as per contingency plan</td>
</tr>
</tbody>
</table>

**Develop a strategy for decommissioning the radar network by 2021 ensuring that an adequate network of back-up surveillance remains in place**

- Contingency plan developed to ensure fail-safe surveillance system
  - Ensure that in case of a GNSS outage, all airborne aircraft can be safely recovered
  - Ensure continuity of service can be maintained at international airports and on the main trunk routes
  - Make provision for some controlled airspace to be designated for transit lanes and special areas for non-ADS-B equipped aircraft
- Contingency plan implemented
- By 2021 some legacy radar remains, or alternate installed at strategic points in accordance with contingency plan

**Install network of ADS-B receivers to replace radar network**

- ADS-B ground infrastructure in place to provide coverage above FL245
- ADS-B ground infrastructure provides coverage of all controlled airspace

**Require ADS-B equipment to be installed on aircraft in a staged way**

- Approved ADS-B transponder required in all aircraft operating above FL245.
- Approved ADS-B transponders required in all controlled airspace

**Implement an education programme for operators, pilots and air traffic controllers on future ADS-B installation and operational requirements**

- Operator procedure guidelines developed
- Education programme for operators, pilots and air traffic controllers on ADS-B installation, and operational requirements.
- Training standards updated
- Training requirements for use of ADS-B equipment included in training curriculum

**Develop rules to allow progressive implementation of ADS-B airspace**

- Rule development – timelines and specifications for equipage and operator requirements
- ADS-B Capability register
- Review of technologies, including multistatic primary surveillance radar and options for self-surveillance using ADS-B IN.
**Communications – Incremental Improvements**

**INTRODUCTION**

Communications play a vital role in air navigation. They provide the contact between the aircraft and the ground that keeps aircraft safe ensures efficient aircraft flow, and provides the aeronautical and weather information that enables good decision making. Ground communications link Air Traffic Service facilities, both domestically and internationally, and also provide the networks for the distribution of aeronautical and meteorological information.

**Radio communications**

Early aviation communication was achieved using signalling techniques such as flags and flares. By the 1930s, radio communications had become essential to aviation safety and efficiency, with ICAO’s predecessor, the International Commission for Aerial Navigation agreeing that all aircraft with 10 or more passengers should carry radio. Voice radio communications between air and ground generally use the very high frequency (VHF) range, with some use of high frequency (HF) for trans-oceanic flights. **Satellite communication (SATVOICE)** has been available since the early 1990s, but its use in aviation is limited at present.

100 years on from its initial introduction, radio voice communications are being supplemented by digital data communications to enhance over-the-horizon communications and to make more efficient use of the limited radio spectrum available.

**Data-link – communications**

Digital data-link technology has made a significant change to aviation communications, particularly in remote and oceanic airspace.

**Automatic Dependent Surveillance Service – Contract (ADS-C)** is a system for automated aircraft position reporting by data-link. Reports are sent at specified intervals, or events, in accordance with a ‘contract’ set by the air traffic service provider during the ADS-C log-on process.

**Controller Pilot Data Link Communications (CPDLC)** is used to send standard messages between aircraft and air traffic controllers. CPDLC does not yet provide the almost instantaneous communication of VHF voice and is mainly used for oceanic and remote continental operations.

Within most regions except Europe, the data-link process is known as FANS 1/A and is based on the ACARS system. Within the EU, the Baseline 100 ATN-based system is used (see definitions below). Both use the Inmarsat satellite network, with some use of the MTSAT (Multifunctional Transport Satellites) and Iridium networks.

The introduction of IP (internet protocol)-based networks for data-link systems is likely to reduce communications costs. Implementation is unlikely before 2015.

**Ground-Ground communication**

Ground-ground communications are also undergoing change. Over the next 5 years, the Aeronautical Fixed Telecommunication Network (AFTN) will be replaced by the Aeronautical Message Handling System (AMHS). The AMHS will form the basis for the Aeronautical Telecommunication Network (ATN), which will be the new standard for transfer of information in the future. The ATN will use more modern protocols and be capable of handling longer messages at higher speeds than the AFTN.

---

**FANS**: (Future Air Navigation System) FANS 1/A is the system by which CPDLC and ADS-C messages are carried within the ACARS message framework.

**ACARS**: (Aircraft Communications Addressing and Reporting System) is a messaging protocol that was designed by a communications service provider, ARINC, to replace its VHF voice service in 1978. It uses telex formats. Another communications provider, SITA, later added an ACARS capability to its worldwide network.

**ATN**: Aeronautical Telecommunications Network (ATN) is a global internetwork architecture that allows ground, air-ground and avionic data sub-networks to exchange digital data. Over the next 20 years, ACARS will be superseded by the more efficient and secure ATN protocol for ATC and airline communications.

**AFTN**: The Aeronautical Fixed Telecommunication Network is a worldwide system of aeronautical fixed circuits for the exchange of messages and digital data between aviation users. The system carries distress, urgency, flight safety, meteorological, flight regularity and aeronautical administrative messages.
INTERNATIONAL DEVELOPMENTS

Ground-Air communications

Given current technology, the following trends in aviation communication are likely during the period of this Plan, as recognised in the ICAO Global Air Navigation Plan (see Table 3):

- VHF voice communications will remain the primary method of communication in non-remote continental airspace.
- The use of data-link within non-remote domestic airspace is unlikely except within Europe.
- Use of HF voice communications will decline, replaced to some extent by SATVOICE (satellite phone technology).
- Internet protocol (IP) capability is likely to be introduced.
- In the longer term, digital radio may be introduced for voice communications.
- In the very long term, the difference between communications and surveillance will become blurred as technology is introduced to enable information sharing between aircraft and air traffic management.

Internationally, the following changes in technology are occurring:

- **Europe** – ATN Baseline 1 CPDLC data-link services are being implemented. The ATNB1 package is currently being deployed in 32 European flight information regions above FL285. The new requirement mandates the carriage of ATN-B1 equipment by aircraft above FL 285 from February 2015.
- **The USA** will introduce departure clearances using FANS 1/A+ in 2014.

The worldwide use of data-link is set to increase as more States adopt the technology. The development of ATN Baseline 2 as the replacement for FANS 1/A will take place over the next few years.

Ground-Ground communications

ICAO is promoting the transition from the Aeronautical Fixed Telecommunications Network (AFTN) to the Aeronautical Message Handling System (AMHS). The AMHS is a precursor to the Aeronautical Telecommunications Network (ATN).

### TABLE 3: ICAO BLOCK UPGRADES RELATED TO COMMUNICATION

<table>
<thead>
<tr>
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<th>Block 0</th>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
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<tbody>
<tr>
<td><strong>Improved Safety and Efficiency through Data-Link (TBO)</strong></td>
<td>Initial set of data-link applications for surveillance and communications in air traffic control</td>
<td>Improved synchronisation of traffic flows at en-route merging points, and optimisation of approach sequence through the use of 4D TRAD* capability and airport applications (eg D-Taxi) via the air-ground exchange of data related to a single controlled time of arrival</td>
<td>Trajectory based operations deploys an accurate four dimensional trajectory that is shared among all of the aviation system users and provides consistent and up to date information system wide which is integrated into decision support tools facilitating global ATM decision making</td>
<td></td>
</tr>
<tr>
<td><strong>Remotely Piloted Aircraft Systems (RPA)</strong></td>
<td>Initial Integration of Remotely Piloted Aircraft (RPA) Systems into non-segregated airspace Implementation of basic procedures for operating RPA in non-segregated airspace including detect and avoid.</td>
<td>RPA Integration in Traffic Implements refined operational procedures that cover lost link (including a unique squawk code for lost link) as well as enhanced detect and avoid technology.</td>
<td>RPA Transparent Management RPA operate on the aerodrome surface and in non-segregated airspace just like any other aircraft</td>
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</table>

*4D trajectory management is expected to improve air traffic operations, in particular to increase the overall predictability of traffic. The operator and service provider agree a target time of arrival over a waypoint of the trajectory, within a set tolerance.*
CURRENT STATUS IN NEW ZEALAND

Aeronautical communications fall within the Aeronautical Fixed Service (AFS), the Aeronautical Mobile Service (AMS) and the Aeronautical Mobile Satellite Service (AMSS).

The two mobile services include the Route services – AM(R)S and AMS(R)S. These are reserved for communications relating to regularity and safety of flights. All Air Traffic Service communications are Route services, as are most airline operational control (AOC) communications. Off-route (OR) services are intended for non-safety communications such as flight coordination and airline administration control.

Fixed Services

**ATS direct speech circuits:** Air Traffic Service direct speech circuits provide direct voice communications between air traffic units, both domestically and internationally. These are typically used for coordination of traffic.

**Ground-ground messaging:** The Aeronautical Fixed Telecommunication Network (AFTN) provides for the exchange of messages or data between stations. Its uses include passing flight plan and AIDC (air traffic control interfacility data communications) messages and disseminating NOTAM (notices to pilots). NZ is connected to the international network through Airways’ Christchurch Centre and the Brisbane and Salt Lake City Communication Centres.

The Aeronautical Message Handling System (AMHS) will replace the Aeronautical Fixed Telecommunications Network (AFTN) as the means of exchanging messages by 2016.

AIDC coordination messages and meteorological messages are carried over the AFTN, and will also transition to the AMHS.

**Mobile Services:** The AM(R)S is used for voice communications between aircraft and Air Traffic Service units and for some airline operational control (AOC) communications. Most AM(R)S uses VHF frequencies between 118 and 130 MHz, though a number of HF frequencies are available where there is no VHF coverage (for example, on oceanic routes). Airways has an extensive network of VHF facilities across the country and HF facilities at Auckland, while various air operators provide facilities for AOC.

The AM(OR)S is generally used for airline administrative communications on frequencies between 130 and 137 MHz or at HF, with ground facilities are provided by the air operators.

There is some use of the AMS(R)S for SATVOICE communications, though at present this is limited to urgent, non-routine communications.

**Air-ground data communications:** The AM(R)S is also used for data-link communications, for both ATS and AOC purposes. These data-link services are generally provided by communication service providers such as ARINC and SITA.

Most data-link traffic is carried in the AMS(R)S. The main uses are oceanic controller-pilot data-link communications (CPDLC) and automatic dependent surveillance – contract (ADS-C). Air operators also use data-link for aeronautical operational control (AOC).

Currently, CPDLC and ADS-C follow the FANS 1/A protocols and are carried via the Aircraft Communications and Reporting System (ACARS).
CHALLENGES FOR NEW ZEALAND

Most changes in the communications area on the horizon are related to improvements in the technology such as the transition to AMHS, and then to the ATN protocol.

However there are some technologies that may have more direct implications for operators in the longer term- including data-link systems and Remotely Piloted Aircraft.

High Frequency Radio

High Frequency radio is not an ideal communications medium, and many newer aircraft are already equipped with satellite communications (SATVOICE). New Zealand does not yet permit SATVOICE as a primary means of communication, though this is likely to change as SATVOICE technology improves and becomes more economical.

Volume of air traffic in NZ

The volume of traffic in New Zealand is not significant, and even at the larger international airports at peak flow, we have not yet reached capacity with the radio communication network.

However, with the improved routing through PBN, and the proposed introduction of an ADS-B ground network from 2018, along with improvements in traffic flow, all resulting in reduced separation requirements, the need for a more efficient communication system may become more apparent in our busier airspace.

Introduction of data-link

Technical development of data-link systems continues, with potential for interfacing with a range of other avionics systems.

While present spectrum allocations are adequate, increases in the use of data-link systems may stretch the limits of the bandwidth available for data-link via satellite. Success of aeronautical data-link systems depends upon adequate bandwidth as well as sufficient data processing capability on the ground and in the air.

Costs associated with installation of a full data-link system in aircraft are high and certainly outside the current scope of the general aviation community. Technology costs would need to reduce significantly before data-link becomes an option for smaller operators.

International operations

New Zealand’s international operators are generally equipped for CPDLC and ADS-C. However, for the future these operators may need to consider the changes proposed in Europe and the move to ATN B2. This will be especially important over the next 20 years as ACARS is superseded by the faster and more secure ATN.

Remotely Piloted Aircraft

One significant challenge for New Zealand is the potential increase of Remotely Piloted Aircraft. Both data-link and voice systems will be required to ensure that they are managed effectively.

Human factors

Should New Zealand choose to implement data-link systems into its domestic communications framework, or require changes to the international equipage requirements, the transition from a predominantly voice communication environment to a predominantly messaging environment will need to be effectively managed. This change would require a major shift in pilot, operator and air traffic controller behaviour and training, as well as the development of new procedures to maintain a safe operating environment for all.

Back-up systems

As with any new technology implementation, failsafe systems will always be needed. Given current technology development, a dual voice or data-link combination is still likely to be required.
**PLAN FOR COMMUNICATION**

**Stage 1 (2015):** Ongoing maintenance of the VHF network. Complete transition from AFTN to AMHS. Develop policy for Remotely Piloted Aircraft communications.

**Stage 2 (2018):** Introduce international pre-departure clearances via data-link and review demand for additional use of data-link technology. Introduce voice over IP for linking to remote sites and for ground communication. Transition to ATN. Implement Remotely Piloted Aircraft Policy.

**Stage 3 (2023):** VHF communication remains the primary means of domestic communication. Implement results of review on data-link technology. Approve SATVOICE as a primary means of voice communication in oceanic controlled airspace.

### Objectives

- VHF voice will continue as the primary communication medium in the domestic environment
- Introduce further options for aircraft operating in Oceanic airspace: Implement Baseline 2 (using ATN) in parallel with FANS 1/A
- Implement communications policy for Remotely Piloted Aircraft to ensure full integration with other aircraft in non-segregated airspace
- Develop new protocols for communications
  - Complete transition from AFTN to AMHS and then to ATN
  - Introduce voice over IP (VOIP) for linking to remote sites and for ground communication
- Review demand for data-link in the domestic environment – including
  - Aerodrome Mobile Airport Communication System (AeroMACS) data-link system
  - L-Band Data-link Aeronautical Communications (LDACS) technology
- International Pre-departure clearances via data-link (ARINC 623) from 2014
- Accept SATVOICE as a primary communication medium in oceanic controlled airspace

### Principles

- Closely follow other countries’ lead in this area
- Take into account likely developments in data-link systems, and ensure that any New Zealand implementation provides maximum economic and safety benefits
- There is sufficient availability of radio frequency spectrum
- Consider costs carefully prior to implementing any new communications requirements
- Take account of Remotely Piloted Aircraft
- Ensure changing systems do not increase the workload of pilots and air traffic controllers
## Communication Actions

<table>
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<tr>
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<tbody>
<tr>
<td>Business as usual, with a transition from AFTN to AMHS</td>
<td>Introduction of some new protocols, methods and technologies</td>
<td>Transition to ATN</td>
</tr>
<tr>
<td>Review demand for data-link technology in domestic airspace</td>
<td>On-going maintenance of the VHF network</td>
<td>Accept SATVOICE for primary communications</td>
</tr>
<tr>
<td>On-going maintenance of the VHF network</td>
<td>On-going maintenance of the VHF network</td>
<td>Implement results of review on data-link technology</td>
</tr>
<tr>
<td>VHF voice to continue as the primary communication medium in the domestic environment</td>
<td>On-going maintenance of the VHF network</td>
<td>On-going maintenance of the VHF network</td>
</tr>
<tr>
<td>Additional options for Oceanic airspace aircraft equipped with FANS1/A data-link.</td>
<td>Enable aircraft to use HFDL as a back-up.</td>
<td>Implement Baseline 2 (using ATN) to implemented in parallel with FANS 1/A.</td>
</tr>
<tr>
<td>Communications policy for Remotely Piloted Aircraft</td>
<td>Remotely Piloted Aircraft: All data-link and voice CNPC in non-segregated airspace must operate within the AM(R)S or AMS(R)S.</td>
<td></td>
</tr>
<tr>
<td>Develop policy for Remotely Piloted Aircraft</td>
<td>Complete transition from AFTN to AMHS</td>
<td>Develop new protocols</td>
</tr>
<tr>
<td>Implement ATN</td>
<td>Develop new protocols</td>
<td>Introduce and review demand for additional communication methods—SATVOICE and Data-link</td>
</tr>
<tr>
<td>Introduce voice over IP (VOIP) for linking to remote sites and ground communication</td>
<td>Complete transition from AMHS to ATN</td>
<td>Implement ATN</td>
</tr>
<tr>
<td>Review demand for data-link in the domestic environment — including for:</td>
<td>Oceanic: SATVOICE supersedes HF as primary voice system</td>
<td>Introduce and review demand for additional communication methods—SATVOICE and Data-link</td>
</tr>
<tr>
<td>Aerodrome Mobile Airport Communication System (AeroMACS) data-link system</td>
<td>Implement results of data-link reviews</td>
<td>International Pre-departure clearances via data-link (ARINC 623) from 2014</td>
</tr>
<tr>
<td>L-Band Data-link Aeronautical Communications (LDACS) technology</td>
<td></td>
<td>Review demand for data-link in the domestic environment — including for:</td>
</tr>
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Aeronautical Information Management – Digital and integrated

INTRODUCTION

The Aeronautical Information Service is still largely based on a suite of paper-based publications and charts with some online accessibility of information. It includes:

- The Aeronautical Information Publication (AIP), including amendments and supplements. This document contains most of the information a pilot needs about procedures and aerodromes.
- NOTAMs (Notices to Airmen) – alerts to aircraft pilots of any hazards en-route or at a specific location.
- Aeronautical Information Circulars (AIC); notice containing information that does not qualify for the origination of a NOTAM or for inclusion in the AIP, but which relates to flight safety, air navigation, technical, administrative or legislative matters.
- Pre-flight Information Bulletins: Summaries of the above disseminated to pilots via internet, phone or fax before a flight to assist in flight planning.

Over the next 10 years, the aviation system will become more responsive to demand, with the development of airborne navigation technology, surveillance systems and direct ground-air data-links.

To accommodate this, paper based systems will need to progress to digital data-driven systems that allow continuous, up-to-date and real-time transfer of the full range of aeronautical information to all participants in the aviation system, in the air and on the ground.

ICAO calls this the transition from aeronautical information services (AIS) to aeronautical information management (AIM).

INTERNATIONAL DEVELOPMENTS

The provision of aeronautical information today is mainly focused on the requirements for the Aeronautical Information Publication, aeronautical charts and for pre-flight briefing.

In the future, aeronautical information provision will address the requirements of all components of the aviation system for all phases of flight. The timely availability of high-quality and reliable aeronautical, meteorological, airspace and aerodrome information is a critical pre-requisite for the development of the many new tools that future aviation systems will employ to enable a collaborative, interoperable and flexible decision-making environment.

There is an international drive to transition aeronautical information services to a digitalised and holistic information management system covering all aspects of aviation information management. The two related elements in the ICAO Global Air Navigation Plan (Doc 9750) set out in Table 4.

<table>
<thead>
<tr>
<th>TABLE 4: ICAO BLOCK UPGRADES RELATED TO AERONAUTICAL INFORMATION</th>
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<tr>
<td><strong>Block 0</strong></td>
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<tr>
<td>Digital Aeronautical Information Management (DATM):</td>
</tr>
<tr>
<td>Application of System Wide Information Management (SWIM)*</td>
</tr>
</tbody>
</table>

*SWIM is intended internationally to be a cornerstone of future developments in aeronautical information, but work is still under way in international bodies to agree on SWIM definitions, concepts and potential solutions.
ICAO has also developed a roadmap for the international transition to aeronautical information management. New Zealand is making good progress to date as set out in Table 5 below. The transition to AIM will not involve many changes in terms of the scope of information to be distributed but rather the method of delivery and access. The major change will be the increased emphasis on information management and real-time data distribution.

**TABLE 5: NEW ZEALAND AIS TO AIM IMPLEMENTATION PROGRESS**

<table>
<thead>
<tr>
<th>Roadmap Steps</th>
<th>Deadline</th>
<th>NZ Status</th>
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<tbody>
<tr>
<td><strong>Phase 1</strong>&lt;br&gt;Consolidation&lt;br&gt;P-03 — AIRAC adherence monitoring&lt;br&gt;P-04 — Monitoring of States’ differences to Annex 4 &amp; 15&lt;br&gt;P-05 — WGS-84 implementation&lt;br&gt;P-17 — Quality</td>
<td></td>
<td>Complete</td>
</tr>
<tr>
<td><strong>Phase 2</strong>&lt;br&gt;Going digital&lt;br&gt;P-01 — Data quality monitoring&lt;br&gt;P-02 — Data integrity monitoring&lt;br&gt;P-06 — Integrated aeronautical information database&lt;br&gt;P-07 — Unique identifiers&lt;br&gt;P-08 — Aeronautical information conceptual model (AICM)*&lt;br&gt;P-11 — Electronic AIP&lt;br&gt;P-13 — Terrain&lt;br&gt;P-14 — Obstacles&lt;br&gt;P-15 — Aerodrome mapping</td>
<td>2015</td>
<td>In Progress</td>
</tr>
<tr>
<td><strong>Phase 3</strong>&lt;br&gt;Information management&lt;br&gt;P-09 — Aeronautical data exchange&lt;br&gt;P-10 — Communication networks&lt;br&gt;P-12 — Aeronautical information briefing&lt;br&gt;P-16 — Training&lt;br&gt;P-18 — Agreements with data originators&lt;br&gt;P-19 — Interoperability with meteorological products&lt;br&gt;P-20 — Electronic aeronautical charts&lt;br&gt;P-21 — Digital NOTAM</td>
<td>2010-2018</td>
<td>In Progress</td>
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</table>

*AIXM Conceptual Model provides a formal description of the aeronautical information items, using a standard data modelling language.

**STATUS OF AERONAUTICAL INFORMATION MANAGEMENT**

The gathering and dissemination of aeronautical information is governed by ICAO Annex 15 and Annex 4. This defines how an aeronautical information provider should receive and/or originate, collate or assemble, edit, format, publish/store and distribute specified aeronautical information/data.

In New Zealand, these requirements are reflected in Rule Part 175 requirements and delivered by Airways New Zealand, under contract to the Civil Aviation Authority.

New Zealand has completed the development of the New Zealand Plan for the Transition from AIS to AIM in accordance with the ICAO Roadmap for the transition from AIS to AIM (2009).

The current aeronautical information service (AIS) is a mix of paper-based and electronic processes and products. This mixed-modal approach is supported by:

- **A single source database**: New Zealand has completed the migration of all static aeronautical information to a single database that is compliant with international standards (the ICAO mandated aeronautical information exchange model AIXM)
Online information: New Zealand currently makes both the aeronautical information publication New Zealand (AIP) and Notices to Airmen (NOTAM) information available via web browsers. The AIP is available in PDF format on the AIP website. NOTAM/Briefing information is available via HTML on Airways Internet Flight Information Service (IFIS).

Replacement of legacy systems with digital solution: Airways New Zealand is currently undertaking a lifecycle replacement programme for its legacy NOTAM/Briefing system. The legacy system will be replaced with a digital solution that is compatible with the single source database AIXM in 2014.

Electronic terrain and obstacle data (eTOD): Area 1 terrain data is currently available from the State topographic mapping agency, Land Information New Zealand. A system of collation and promulgation of Area 2, 3, and 4 eTOD is being developed and finalised. Aerodrome operators are being made aware of obstacle survey requirements for eTOD as required by Annex 15.

As a Part 175 certificate holder, Airways operates an ISO 9001 certificated quality management system that covers the full range of operational activities, including aeronautical information services. Originators of data are required to confirm data integrity upon submission and also annually confirm that data published by them is correct and up to date.

CHALLENGES FOR NEW ZEALAND

In New Zealand, progress is already being made towards a transition to aeronautical information management. Challenges in AIM implementation in New Zealand include:

System Wide Information Management (SWIM)

There are significant issues associated with resolving the institutional and legal issues that encompass, among others, organizational, financial and intellectual property aspects associated with the system-wide management of aeronautical information.

Rapid technological change

Outside of the ICAO requirements there is a proliferation of technology-based products that can be used for aviation purposes but are non-traditional in nature or provided by non-certificated or non-aviation organisations. A key question for New Zealand relates to what products should be provided outside the ICAO requirements, and who should provide them.

Technology is advancing faster than aeronautical information management can adapt, especially in areas of non-Annex 15 aeronautical data and non-air transport operations. For example the provision of aeronautical charting in digital form may be suitable for Flight Management Systems but not for individual pilots who want applications on “smart” phones, hand-held computers and tablet devices. This is an area that must be monitored and solutions assessed as appropriate.

Assurance of quality and integrity of data

Moving to a data-centric system, as distinct from product-centric, requires assurance of quality and integrity of data before and when it gets to the end-user. There is already a lot of information that is accessible but not necessarily to a standard suitable for regulated safety systems (e.g. third party products). A key part of the information management system might be to manage non-certified aeronautical information/data that can potentially affect the safety of air navigation.

Human factors

Evolution from paper based systems to computerised data-based systems will occur over an extended period, with present and future styles of operation proceeding in parallel. Changing the presentation and source of information will bring its own challenges, and will necessitate new skill development for all groups of users, from pilots to air traffic controllers to staff involved in producing the information.

Maintenance of data

It will be increasingly necessary in a digital and “real time” environment to ensure on-going maintenance of data to ensure it is accurate and up-to-date.
PLAN FOR AERONAUTICAL INFORMATION

Stage 1 (2015): Going digital: Complete transition from AIS to AIM in accordance with ICAO roadmap
Stage 2 (2018): Integration of data and systems
Stage 3 (2023): Real time availability of data into aircraft

Objectives
Q Complete digitalization of information in accordance with the ICAO roadmap
   o P-08 — Aeronautical information conceptual model
   o P-14 — Obstacles
   o P-15 — Aerodrome mapping
   o P-20 — Electronic aeronautical charts
Q Ensure information management is integrated in accordance with ICAO roadmap
   o P-09 — Aeronautical data exchange
   o P-10 — Communication networks
   o P-12 — Aeronautical information briefing
   o P-16 — Training
   o P-18 — Agreements with data originators
   o P-19 — Interoperability with meteorological products
   o P-21 — Digital NOTAM
Q New digital aeronautical data accessible to all participants in the system – with a focus on
   o Real-time availability of data both on the ground and in the air
   o Manage human factors associated with accessibility of data on new applications and devices

Principles
Q Guided by the Global Air Navigation Plan (Doc 9750 and ICAO Roadmap
Q Data is accurate and reliable and scalable
Q Keep any required equipment upgrade costs to a minimum by building on existing developments
Q Limit any disruption to supporting systems and infrastructure network is mitigated

Aeronautical Information Actions

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<tr>
<td><strong>Objectives</strong></td>
<td>Going digital: Complete transition from AIS to AIM in accordance with ICAO roadmap</td>
<td>Integration of data and systems</td>
<td>Real time availability of data into aircraft</td>
</tr>
<tr>
<td>Start digitalization of remaining information domains in accordance with the ICAO roadmap</td>
<td>P-08 — Aeronautical information conceptual model (AICM)*</td>
<td>P-20 — Electronic aeronautical charts</td>
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<td></td>
<td>P-14 — Obstacles</td>
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<tr>
<td></td>
<td>P-18 — Agreements with data originators</td>
<td></td>
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<tr>
<td>Make digital aeronautical data accessible to all participants in the system</td>
<td>Real-time availability of some aeronautical information</td>
<td>Real-time availability of data to the aircraft</td>
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</tr>
<tr>
<td>Manage human factors associated with data availability</td>
<td>Assess implications of growing use of devices (smartphones, i-Pads etc) in aircraft and review regulatory requirements</td>
<td>Education programme on future information systems – includes use of devices and applications to access information</td>
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</table>
INTRODUCTION
In the other elements of this Plan, we have explored the potential of future technologies to improve the efficiency and safety of airspace use – including performance based navigation through access to satellite technology, more accurate position reports through ADS-B, faster and better quality communications, more integrated and better quality information and streamlining of airspace design in response to demand.

Central to all of these new technologies is the presence of air traffic control – the current single coordination point for all air and ground operations.

Early air traffic control tools were simple: a red flag for "hold" and a checked one for "go."

By World War II, Air Traffic Controllers were already relying on the integration of a mix of different technologies to identify the position of the aircraft (radar), communicate with the pilots (radio) and collect the information they needed to be able to direct traffic to their intended destination.

Then came progress in surveillance by combining radar and radio communications with integrated air traffic control networks. Modern systems utilise computer systems, digital equipment and modern CNS (communications, navigation and surveillance) to provide a complete air traffic management service.

This chapter examines the role that this service will play in the future, and the tools that can be employed to improve the flow of air traffic and ensure safety as our skies become busier.

INTERNATIONAL DEVELOPMENTS
The modern vision for the Air Traffic Management (ATM) system is based on the provision of services with a view to becoming air traffic-enabling rather than air traffic controlling.

This service-based framework considers all resources to be part of the ATM system, including airspace, aerodromes, aircraft, and humans. An ATM system functions through the collaborative integration of humans, information, technology, facilities and services, supported by air, ground and/or space-based communications, navigation and surveillance.

Air Traffic Management (ATM), is defined by the International Civil Aviation Organization (ICAO) as

“The dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management — safely, economically and efficiently — through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.”

A large number of the block upgrades contained in ICAO Global Air Navigation Plan are designed to provide a pathway to an enabling integrated air traffic management system (see Table 6). A modern air traffic management system includes increased integration of air traffic control information tools for air traffic controllers to manage traffic flows.

These tools bring together many of the technologies discussed in previous chapters to provide core outcomes for future airspace management – less delay, greater efficiency, better coordination and collaboration and improved safety and environmental benefits.
TABLE 6: ICAO BLOCK UPGRADES RELATED TO AIR TRAFFIC MANAGEMENT

<table>
<thead>
<tr>
<th>Block 0</th>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
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<tr>
<td><strong>Increased runway throughput through optimised wake turbulence separation (WAKE)</strong></td>
<td><strong>Revision of current ICAO wake vortex separation, minima and procedures</strong></td>
<td><strong>Dynamic wake turbulence separation – based on real-time identification of wake vortex hazards</strong></td>
<td><strong>Advanced (time-based) wake turbulence separation – time based aircraft to aircraft wake separation, and changes to the procedures the service provider applies to the wake separation minima</strong></td>
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<tr>
<td><strong>Improved Traffic flow through sequencing (AMAN/DMAN) – (RESQ)</strong></td>
<td><strong>Time based metering to sequence departing and arriving aircraft</strong></td>
<td><strong>Integration of surface management with departure sequencing to improve efficiency</strong></td>
<td><strong>Synchronised AMAN/DMAN to promote more agile and efficient enroute and terminal operations</strong></td>
</tr>
<tr>
<td><strong>Increased interoperability, efficiency and capability through ground-ground integration (FICE)</strong></td>
<td><strong>Supports the coordination of ground-ground data communication between ATSU based on inter-facility data communication AIDC defined by ICAO Doc 9694</strong></td>
<td><strong>Introduction of FF-ICE step one, to implement ground-ground exchanges using common flight information reference model FIXM, XML and the flight object8 used before departure</strong></td>
<td><strong>Fully synchronised network management between departure airport and arrival airports for all aircraft in the air traffic system at any given point in time</strong></td>
</tr>
<tr>
<td><strong>Improved operations through enhanced en-route trajectories (FRTO)</strong></td>
<td><strong>Allow the use of airspace which would otherwise be segregated (eg military) along with flexible routing adjusted for specific traffic patterns</strong></td>
<td><strong>Introduction of free routing in defined airspace where the flight plan is not defined as segments of a published route network or track system to facilitate adherence to the user preferred profile</strong></td>
<td><strong>Improved operational performance through the introduction of full FF-ICE – all data for all relevant flights systematically shared between air and ground systems using SWIM in support of collaborative ATM and trajectory based operations</strong></td>
</tr>
<tr>
<td><strong>Improved flow performance through planning based on a network wide view (NOPS)</strong></td>
<td><strong>Collaborative ATFM measure to regulate peak flows involving departure slots managed rate of entry into a given piece of airspace for traffic along a certain axis, requested time at a way-point of an FIR/sector boundary along the flight, use of miles in trial to smooth flows along a certain traffic axis and rerouting of traffic to avoid saturated areas</strong></td>
<td><strong>AFTM techniques that integrate the management of airspace, traffic flows, including initial user driven prioritisation processes for collaboratively defining ATFM solutions based on commercial/operational priorities</strong></td>
<td><strong>Introduction of CDM applications supported by SWIM that permit airspace users to manage competition and prioritisation of complex ATFM solutions when the network or its notes no longer provide capacity commensurate with user demands</strong></td>
</tr>
<tr>
<td><strong>Air Traffic Situational</strong></td>
<td><strong>ATSA applications that provide pilots with the means to achieve quicker</strong></td>
<td><strong>Interval management improves the management of traffic</strong></td>
<td><strong>Creation of operational benefits through temporary delegation of</strong></td>
</tr>
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</table>

7 FF-ICE: Flight and Flow Information for a Collaborative Environment describes an evolution from paper based static flight planning to a performance-based system that incorporates integrated information for flow management, flight planning, and trajectory management.

8 The ‘Flight Object’ (FO) is a concept to support the sharing of consistent flight data between all stakeholders. A single logical entity, the FO is kept up to date by all parties wishing to share information about a flight. All parties use the FO as a reference and all keep it updated with the latest information, thereby ensuring that all systems have the most up to date and consistent view of the flight data.
<table>
<thead>
<tr>
<th>Awareness (ATSA)</th>
<th>visual acquisition of targets (AIRB and VSA)</th>
<th>flows and aircraft spacing, precise management of intervals between aircraft with common or merging trajectories maximises airspace throughout while reducing ATC workload along with more efficient fuel burn</th>
<th>responsibility to the flight deck for separation provision with suitably equipped designated aircraft (likely ADS-B IN) – thus reducing the need for conflict resolution clearances while reducing ATC workload</th>
</tr>
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<tbody>
<tr>
<td>Ground based safety nets (SNET)</td>
<td>Assisting the air traffic controller and generating alerts of an increased risk to flight safety e.g. short term conflict alert, area proximity warning minimum safe altitude warning</td>
<td>Reducing the risk of controlled flight into terrain accidents by using Approach Path Monitor</td>
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<tr>
<td>Remotely operated air traffic service (RATS)</td>
<td></td>
<td>Remotely operated Aerodrome Control Tower contingency and remote provision of ATS to aerodromes through visualisation systems and tools.</td>
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<tr>
<td>Airborne Collision Avoidance System (ACAS)</td>
<td>ACAS Improvements To provide short term improvements to existing airborne collision avoidance systems (ACAS) to reduce nuisance alerts while maintaining existing levels of safety. This will reduce trajectory perturbation and increase safety in cases where there is a breakdown of separation.</td>
<td>New Collision Avoidance System Implementation. Airborne Collision Avoidance System (ACAS) adapted to trajectory-based operations with improved surveillance function supported by ADS-B aimed at reducing nuisance alerts and deviations.</td>
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The ICAO Global ATM Operational Concept (Doc 9854) 2005 identifies seven concept components from which to base the provision of integrated services to improve traffic flow:

- **Airspace organisation and management** - dynamic and flexible to ensure that the allocation of resources, restrictions, activities and services support the traffic needs of the day. Restrictions to specific operations should be minimised to the extent possible, to ensure that the overall system is optimised.

- **Aerodrome operations** - enable the efficient use of the capacity of the aerodrome airside infrastructure. Periodic review of infrastructure and procedures with aerodrome operator to ensure maximum efficiency of available capacity and accommodate planned growth/expansion where possible.

- **Demand and capacity balancing** - enable collaborative decision making to balance demand and capacity for the efficient management of air traffic flow within the airspace. This will be supported by the use of information on system wide air traffic flows, weather and assets.

- **Traffic synchronisation** - support establishment and maintenance of a safe, orderly and efficient flow of air traffic including four dimensional trajectory controls, negotiated conflict-free trajectories, elimination of choke points and optimisation of traffic sequencing.
Q **Airspace user operations** - accommodate aircraft with mixed capabilities or define minimum performance standards while ensuring that relevant, secure and quality ATM data is fused with operational information and made available to airspace users.

Q **Conflict management** - enable support of trajectory-based operations while accommodating application of varying standards as defined by the operational needs relating to the specific body of airspace. The performance system may be developed over a period of years as capabilities improve.

Q **ATM service delivery management** - address the balance and consolidation of the decisions of the various other processes/services, as well as the time horizon at which, and the conditions under which, these decisions are made.

In addition, the system must enable the exchange and management of information between the concept components to provide an integrated aviation network with secure, timely and high quality operational information available to all.

With these new tools, the air traffic management task becomes one of strategic management to ensure efficient use of airspace available, based on user preferences.

**CURRENT STATUS IN NEW ZEALAND**

The remote and diverse geographic nature of New Zealand, associated with changeable environmental conditions, makes for a challenging aviation environment. Operations comprise a mixture of commercial and recreational aircraft with a broad mix of capabilities.

The CAA is designated by the Minister of Transport as the Air Traffic Service (ATS) Authority. There is currently only one provider of ATC services – Airways New Zealand – with responsibility for the provision of services in domestic and in oceanic airspace.

**CHALLENGES FOR NEW ZEALAND**

**Adapting to technological change**

With the introduction of greater integration into data management and dissemination, performance based navigation, and more accurate messaging to and from aircraft, Aviation systems are much more technology-reliant and reliable than ever before.

As is occurring world-wide, New Zealand’s future air traffic control systems may need to become more sophisticated to manage technologically advanced aircraft while also ensuring that other operations are considered and accommodated as appropriate.

**Harmonised and interoperable systems**

A key pre-cursor to a more enabling air traffic service in New Zealand is the completion of the integration of aeronautical data and information across various aviation systems.

**Collaborative environment**

Collaboration remains a key component of the developing ATM system. Changes and developments must be facilitated through a robust collaboration process so stakeholders have the opportunity to provide input; this does not mean that complete agreement is necessary. While stakeholders must have the opportunity to provide input, changes and developments will need to be agreed based on the performance of the overall system rather than individual parts.

**Trajectory based management and network management**

Further work is required in the area of network management to understand how strategic management of trajectories can be carried out in practice.

The new operating environment will manage an aircraft’s profile from departure gate to arrival gate including both civil and military operations. This will require greater integration and coordination between control units at the range of different.

New trajectory management tools required will enable controllers to safety manage potential conflicts and provide increased efficiencies across the network. This change will require:

Q Increased use of ATM system tools by controllers and pilots to manage complexity

Q A coordinated implementation of ATM support tools. With re-training of air traffic controllers to process greater amounts of information about aircraft trajectories and management

Q A clear understanding of human performance factors relating to automation

**Contingency planning**

The ATM system will need to include robust contingency capabilities protecting against environmental, industrial and civil disturbances. These capabilities will feature:
safe facilitation of operations already active when the event occurs

the safe continuation of operations to an agreed level depending on the contingency event

Contingency procedures may need to constrain (or exclude) certain operations, such as flight training or general/recreational aviation activities, for a period to maintain the safety of air transport operations, depending on circumstances

**Human factors**
The new tools will reduce controller’s workload; however these will need to be new training and education for all users for the system to work effectively.

An accompanying change in the management of commercial operators to schedule their flights by arrival time rather than departure time may also be required.

**Legal issues**
With legal liability issues around controller use of tools providing de-confliction assurance (passive) instead of using tactical headings to ensure de-confliction (proactive).

It is important that metrics developed be meaningful and measureable without placing undue burden on participants in the short term, and that they are agreed by stakeholders.
PLAN FOR AIR TRAFFIC MANAGEMENT

**Stage 1 (2015):** Infrastructure, procedure and tool development towards trajectory based management, education programmes

**Stage 2 (2018):** Implementation of trajectory based management tools with training and education programmes

**Stage 3 (2023):** Trajectory based management in place supported by integrated information and collaborative processes

**Objectives**

Future air traffic management in New Zealand will move from the concept of tactical control to the concept of strategic control and enabling service provision to facilitate the safe, orderly and efficient flow of traffic.

- Further develop and implement tools, taking into account the needs of end users for
  - synchronised network management between departure airport and arrival airports
  - trajectory-based management – a shift from clearance-based to trajectory-based air traffic control, taking both operator preferences and optimal airspace system performance into consideration
  - conformance monitoring to provide assurance that the track and profile of the aircraft is as expected and being maintained
  - Conflict detection using trajectory prediction and conformance monitoring technology. Conflict detection will support the controllers forward planning - highlighting areas of risk. Assisted by ADS-B and aircraft intent data

- Incorporate all ground and airborne aspects including:
  - Communications improvements
  - More accurate real-time position reporting from aircraft equipped with ADS-B (see surveillance)
  - air traffic services standards and procedures
  - Integrated information management: Better integration of all aeronautical and weather data into the ATM system
  - airport operations; integration with ground management systems to streamline taxi and take-off operations and development of wake turbulence waiting time calculations
  - search and rescue
  - information technology
  - State requirements, including national security

- Ensure that there is adequate contingency planning to enable management during failures in the Air Traffic Management System

- Educate, train and encourage all users (controllers and operators) to operate within the developing environment

- Develop a performance framework with a set of metrics that will provide a measure of performance of the various aspects supporting Air Traffic Management

**Principles**

- Enabling systems will be performance-based, taking a whole of system approach

- Optimise the use of technology on a system-wide basis

- Provide services within a collaborative environment – taking into account the needs of end users
**Air Traffic Management Actions**

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<tr>
<td>Infrastructure, procedure and tool development towards trajectory based management, education programmes</td>
<td>Implementation of trajectory based management tools with training and education programmes</td>
<td>Trajectory based management in place supported by integrated information and collaborative processes</td>
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**Further develop tools—taking into account the needs of end users**
- Development of trajectory based management and network management tools for Air Traffic Controllers
- Network-wide management principles and agreements in place
- Implement hardware and systems for trajectory based management
- Virtual air traffic control testing
- Virtual air traffic control in place at selected locations

**Incorporate all ground and airborne aspects**
- Ensure that ATM systems cater for developments in the other Plan elements

**Ensure that there are adequate contingencies to enable management during failures in the Air Traffic Management System**
- Contingency plan for Air Traffic Management emergency situations amended given introduction of new management systems

**Educate, train and encourage all users (controllers and operators) to operate within the developing environment**
- Education programme on upcoming changes to air traffic management
- Human factors assessment to ensure transition to time based trajectory management and full network management complexities are fully assessed

**Develop a performance framework**
- Develop a set of metrics that will provide a measure of performance of the various aspects supporting Air Traffic Management
- Review of performance of Air Traffic Management System
- Review of performance of Air Traffic Management System
Airspace Design – Review and refine

**INTRODUCTION**
Over the years, to facilitate the flow of traffic, and to keep certain types of air traffic away from each other, a system has been developed that distinguishes areas of airspace that are controlled, and areas that are uncontrolled.

Controlled airspace is established to protect the flight paths of IFR flights, mainly in high volume traffic areas.

Airspace is classified under the International Civil Aviation Organization (ICAO) airspace classification system. This system determines the level of Air Traffic Service (ATS) that will be provided, and whether entry to that airspace requires an ATC clearance.

This level of service cannot be varied by ATC for any given class of airspace. There are seven classes of airspace, New Zealand currently uses four of these:

- **Class A**: IFR flights only are permitted, all flights are provided with air traffic control service and are separated from each other
- **Class C**: IFR and VFR flights are permitted, all flights are provided with air traffic control service and IFR flights are separated from all other flights. VFR flights are separated from IFR flights and receive traffic information in respect of other VFR flights
- **Class D**: IFR and VFR flights are permitted and all flights are provided with air traffic control service. IFR flights are separated from other IFR flights and receive traffic information in respect of VFR flights, VFR flights receive traffic information about all other flights
- **Class G**: IFR and VFR flights are permitted and receive flight information service if requested

There are also types of special use airspace covering restricted areas, military operating areas (MOA), danger areas, volcanic hazard zone (VHZ), mandatory broadcast zone (MBZ), and low flying zones (LFZ)

**INTERNATIONAL DEVELOPMENTS**
ICAO does not include any specific changes in its Global Air Navigation Plan around amendments to airspace design.

However, with the introduction of performance based navigation, a number of countries are reviewing their airspace to take the new route structures into account. Eurocontrol for example is reviewing its airspace structures to provide a more streamlined route structure and airspace design (Single European Sky).

On the long term horizon, it is possible that greater use of self-controlling technologies may require less input from air traffic controllers, thus reducing the volume of controlled airspace.

**STATUS OF NEW ZEALAND AIRSPACE DESIGN**
The CAA is designated by the Minister of Transport as the Airspace Authority and is responsible for the regulatory control and management of New Zealand airspace. New Zealand is also responsible for a large area of international airspace covering the southern South Pacific known as Auckland Oceanic.

Civil Aviation Rule Part 71 empowers the Director to designate and classify airspace within the territorial limits of New Zealand, and airspace for which New Zealand has accepted responsibility under international civil aviation agreements. At present this covers the Auckland Oceanic Flight Information Region and the New Zealand Flight Information Region (FIR). The Director may also restrict aviation activity by the designation of special use airspace.

Rule 71.11 also requires that at intervals of ’at least every five years, the Director must review each current airspace designation and classification to verify the continuing need for the airspace designation or classification.’
New Zealand’s Airspace

**Controlled airspace** is designated where there is a need for an air traffic control service to be provided for the safety and efficiency of aircraft operations. Such designations include

- control areas (CTA) - terminal control area (TMA), upper control area (UTA) or oceanic control area (OCA). At present, only the specification OCA is used within the New Zealand FIR and Auckland Oceanic FIR although the other terms are permitted within Part 71

- control zones (CTR)

The controlled airspace designations do not include all the types of control areas and other airspace that are detailed within the ICAO SARPs and PANS-OPS documents, such as: upper flight information regions (UIR); and aerodrome traffic zones (ATZ)

**VFR transit Lanes or General Aviation Area**: Areas within control areas or control zones may be designated as VFR transit lanes or general aviation areas (GAA). These designations are unique to New Zealand and when active, render portions of the CTR or CTA as Class G uncontrolled airspace.

**Special use airspace** is designated where there is a need to impose limitations on the operation of aircraft for aviation safety and security, or national security, or for any other reason in the public interest.

Part 71 does not include provision for the designation of prohibited airspace as defined by ICAO.

**Miscellaneous airspace designations**: include visual reporting points, area QNH zones and mountainous zones. The mountainous zones were designated in the 1960s and have not been reviewed since then.

**Non-designated airspace** descriptors in New Zealand include parachute landing areas and common frequency zones.

**Transponder mandatory airspace**: Transponder mandatory airspace may only be designated within controlled or special use airspace.

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9 Some unique airspace designations that maybe used within New Zealand are not supported by ICAO regulatory material (SARPs), and in some instances, their design and implementation can create unintended consequences.

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**CHALLENGES FOR NEW ZEALAND**

With the changes signalled in other parts of this plan, it is clear that New Zealand’s Airspace design will need to be reviewed to accommodate increasing traffic, new types of aircraft and more direct and efficient flight paths.

**Performance Based Navigation Routes**

The major technological change affecting airspace design in recent years has been the shift from the use of ground-based aids for air navigation to space-based (GNSS) aids resulting in new performance based navigation routes. Combined with improvements in air traffic management, there will ultimately be more free-routing trajectories.

In addition, increase in demand and pressure on available space will also see a need to review our existing structures to identify on a more regular basis where the pressure will be, and what can be done to alleviate it.

**Integration of new technologies**

New Zealand will see an expansion in remotely piloted aircraft which will need accommodating within the airspace system. Commercial interests are also starting to develop an expanded space industry, and more rocket launch sites in a wider range of countries are being established around the world. There are plans for a commercial launch site in New Zealand in the near future.

These technologies have increased requests to use airspace which was previously not required for the activity, thus adding greater complexity to the design task.

**Aircraft equipage**

With the introduction of new technologies enabling better navigation guidance and surveillance of aircraft, it follows that only those suitably equipped aircraft will be able to enter controlled airspace to meet air traffic management requirements.

While the changes in Navigation and Air Traffic Management are likely to result in smaller controlled areas (as operations become more efficient), provision for aspects of the GA community may need to be included to enable some ongoing access.
PLAN FOR AIRSPACE DESIGN

Stage 1 (2015): Review existing designations, and develop methodology and triggers for future reviews

Stage 2 (2018): Full review of NZ airspace

Stage 3 (2023): Ongoing review of airspace impacts from new technologies.

Objectives

Q Review existing designations to determine what changes or additions are necessary, including consideration of other ICAO airspace designations

Q Airspace reviews to become more demand driven. Develop triggers and methodology for airspace reviews to take into account milestones and significant changes in activity:
   o Base any reviews on a clear understanding of future needs – including specific operator requirements, traffic volumes and types of aircraft such as remotely piloted aircraft and rockets
   o Ensure protection of nationally important airspace – including for security and defence, environmental protection and economic importance
   o Be coordinated with other jurisdictions
   o Ensure that all airspace redesign is undertaken in a consultative way. There should be general guidance as to who should be included in process, as well as how the process should be managed
   o Disseminate information and training to operators about the changed routes and airspace structures

Q Reassess provisions relating to transponder requirements – including an assessment of whether uncontrolled airspace should be transponder mandatory, if it is deemed necessary for enhanced safety, without the need for special use airspace to be established

Q Consider what, if any, variations to airspace rules and procedures could be applicable to cover aircraft emergencies and civil emergencies

Principles

Q Airspace boundary definition methods should be kept as few and as simple as possible. The primary driver of the placement of boundaries should be utility, rather than convenience, such as aircraft performance (i.e. the rate of climb/descent), adjacent aerodromes/airspace users etc....

Q Maximise benefits of new navigation, communication, information and surveillance technologies and operating techniques

Q Address changing environmental impacts (noise, emissions) and the likely reaction to this.
## Airspace Design Actions

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Review existing designations, and develop methodology and triggers for future reviews</td>
<td>Full review of NZ airspace</td>
<td>Ongoing review of airspace impacts from new technologies</td>
</tr>
<tr>
<td><strong>Review existing designations</strong></td>
<td>Review existing designations to determine what, if any, changes or additions may be necessary, including consideration of other ICAO airspace designations.</td>
<td>Review existing designations to determine what, if any, changes or additions may be necessary, including consideration of other ICAO airspace designations.</td>
</tr>
<tr>
<td><strong>Develop triggers and methodology for airspace reviews to take into account milestones and significant changes in activity</strong></td>
<td>Develop triggers and methodology for future airspace reviews Define the methodology in guidance documents, including consultation requirements.</td>
<td>Full review of NZ airspace based on the methodology.</td>
</tr>
<tr>
<td>Reassess provisions relating to transponder requirements –</td>
<td>With the introduction of ADS-B, review transponder mandatory airspace requirements</td>
<td></td>
</tr>
<tr>
<td><strong>Consider whether there should be any variations to airspace rules and procedures</strong></td>
<td>Review airspace provisions relating to emergencies and civil emergencies taking changes in navigation, surveillance and air traffic management changes into account.</td>
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Aerodromes – Increasing capacity

INTRODUCTION
Aerodromes have come a long way since the use of grass paddocks. Paving, runway lighting, commercial passenger terminals and slope lighting progressively improved services offered by airports. During the 1960s Airport construction boomed with the increase in jet aircraft traffic. Runways were extended and jet bridge systems were added to modern airport terminals.

In more recent times, the aerodrome infrastructure capability can be a limiting factor when attempting to improve traffic flows and improve system capacity. This ever increasing pressure on aerodrome’s infrastructure means that airport management is driven by a collaborative process of master planning, linking in with both airspace management requirements and land management planning to ensure a seamless service for passengers and operators.

INTERNATIONAL DEVELOPMENTS
World-wide, management of traffic flow at aerodromes is being incorporated into a harmonised and integrated approach to air traffic management. In addition, improved aerodrome design and management activities, including coordination and collaboration between Air Traffic Service providers, vehicle operators and aircraft operators can have an important impact on safety and capacity at aerodromes. Today’s aerodrome operator needs to consider a raft of factors:

- anticipated number and frequency of movements on the runway and in surrounding airspace during peak periods (linking in with airspace management). Enhancing the performance of runway operations begins with the establishment of runway capacity benchmarks. This is usually defined as the maximum number of movements that can be handled per hour in certain weather conditions and for certain operations;
- the mode of runway operation, i.e. mixed, independent, dependant or segregated parallel operations;
- the characteristics of the aircraft that the aerodrome is intending to serve both now and in the foreseeable future;
- the geometric layout of the airport and its taxiway system with the objective to reduce runway occupancy times and provide resilience of operations in the event of maintenance or unserviceability;
- appropriate use and siting of visual aids, including mains power reticulation to the airfield and secondary power requirements;
- the siting of the air traffic control tower to ensure that it can adequately meet its primary purpose, and also to ensure that it will also not pose an impediment to future modes of operation or approach categories;
- the lowest meteorological minima intended for each runway;
- the ambient light conditions intended for the operation of aircraft;
- the ground infrastructure including lighting, taxiways, runway and surface guidance to improve safety and to maximise aerodrome capacity in all weather conditions;
- any activities that take place on the manoeuvering area or apron as these have a direct impact upon ATM. Terminal capacity also has an indirect impact upon the ATM system in that the facilities provided can influence the aircraft turnaround process;
- development of security measures to deal with increasing threats in this area;
- increasing need to manage environmental implications of aircraft movements particularly noise issues, but also management of wild life and impacts of aerodrome expansion.

ICAO has recognised the need for improved flow and collaborative planning to integrate aerodrome management into airspace management in two of its ASBU elements in the Global Air Navigation Plan.

The need for integration with the whole system will become more important with future network-wide air traffic management moving towards flight approvals at the time of departure (meaning that aircraft are held at the departure gate rather than in the air at the arrival point). This means that future management of aerodromes will need to link into en-route and arrival air traffic management systems, and development of databases and data-link systems also include management of air traffic at source.
TABLE 7: ICAO BLOCK UPGRADES RELATED TO AERODROMES

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<thead>
<tr>
<th>Block 0</th>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
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<tbody>
<tr>
<td><strong>Safety and Efficiency of Surface Operations (SURF)</strong></td>
<td>Airport surface surveillance for service providers</td>
<td>Enhanced safety of surface operations and enhanced vision systems – airport surface surveillance for service providers and flight crews with safety logic, cockpit moving map displays and visual systems for taxi operations</td>
<td>Optimised surface routing and safety benefits – taxi routing and guidance evolving to trajectory based with ground/cockpit monitoring and data-link delivery of clearances and information – cockpit synthetic visualisation systems</td>
</tr>
<tr>
<td><strong>Improved airport operations through airport collaborative decision making (ACDM)</strong></td>
<td>Improved airport operations through collaborative decision making (CDM) - Airport operational improvements through the way operational partners at airports work together</td>
<td>Optimised airport operations through airport CDM – Airport operational improvements through the way operational partners at airports work together</td>
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</table>

STATUS OF NEW ZEALAND AERODROME MANAGEMENT

Airports are critical components of New Zealand’s national economic infrastructure. They support trade and tourism and help drive growth across the economy. Continual investment in and upgrading of the aviation infrastructure at airports is needed to continue to drive national productivity and economic performance.

New Zealand airport operators a mix of privately owned companies and local authorities focused solely on the operation of their respective airport in a competitive environment. New Zealand is well advanced in collaborative management with Air Traffic Managers to ensure the most efficient use of aerodrome facilities.

Operating aerodromes include:

- Three main international airports (identified by the ICAO Asia-Pacific Regional Air Navigation Plan), Auckland, Christchurch and Wellington. The three main international airports also serve as domestic hubs for the north, central and southern parts of the country, with regular services to regional areas:
  - Auckland Airport is the main long-haul international airport with the second highest category of precision Instrument Landing System (ILS) being Category IIIB
  - Christchurch Airport also services long haul international operations, as well as forming an international base for flights to and from Antarctica. It has a Category I precision ILS
  - Wellington Airport’s international traffic is predominately Trans-Tasman, together with some seasonal routes to the Pacific Islands. It has a Category I precision ILS

- Five airports who have had or currently have Trans-Tasman services:
  - Queenstown.
  - Rotorua
  - Dunedin
  - Palmerston North: and
  - Hamilton

- 12 regional airports currently have a Part 121 air transport operation and a number of smaller regional airports have a Part 125 air transport operation. (Sept 2013)

- 1 military airbase (Ohakea), is served with an Category I precision ILS and capable of being used as an alternate airport for international operations with prior approval

- around 150 published aerodromes and heliports

Christchurch Airport has two runways able to handle some long haul international aircraft,
although the secondary runway is not served by an ILS and are not necessarily acceptable for some international aircraft.

Collaborative Arrivals Manager (CAM), developed by ACNZ, is an ATM system which has been implemented at capacity constrained Auckland and Wellington airports.

It will be further enhanced through the implementation of Arrivals Manager (AMAN) and Departures Manager (DMAN). A further enhancement embodying both arrivals and departure processes is the development of an Airport Collaborative Decision Making tool. While network-wide in application, its primary use will, like CAM, focused only at capacity-constrained airports.

Many aerodromes in New Zealand have strategic master plans for their airports. The aerodrome at the initial stages of master planning must consider its concept of operations from which to base further planning of infrastructure and services.

**CHALLENGES FOR NEW ZEALAND**

On the whole, major airports in New Zealand are in good shape for the future with good Air Traffic Management Systems and appropriate infrastructure. However there are some areas where further action could be considered.

**Critical infrastructure Aerodromes**

Critical infrastructure Aerodromes such as Auckland Airport currently has some acknowledgement in local land use planning (e.g. noise sensitive areas), but no recognition in land-use planning legislation as nationally critical infrastructure.

**Linkages**

Outside of the main international airports, due to their independent commercial nature, aerodrome operators as a whole have not been actively involved in the collaborative management of the air traffic management (ATM) system. There are opportunities for awareness of airspace implications and their aerodromes’ roles in the national air traffic management system to be raised.

While master planning is in place across many aerodromes, more work may be required to create better linkages beyond the aerodrome, in a network style approach.

**Movement Area Capacity**

While runway and taxiway throughput is usually very streamlined in good weather, significant delays are often experienced in poor weather conditions at many airports. Better linkages across the system are required to manage these situations and avoid holding of aircraft in the air. Monitoring of aircraft movements is important to enable analysis that can trigger appropriate airspace and infrastructure planning measures so that capacity is not artificially restrained.

**Data Exchange**

Predictability in aircraft movements is a challenge faced by aerodromes, particularly during poor weather events. Local collaborative decision-making processes are needed that will lead to sharing of key flight scheduling data that will enable all participants to improve their awareness of aircraft status throughout the “turnaround” process. This will allow precise measures to be applied and higher predictability of schedules to be achieved. This will enable more efficient use of capacity of the aerodrome resources and ground handling, reduction in delays and greater predictability of schedules.

**Land Use Planning**

The Resource Management Act 1991 requires that District Plans are reviewed at periods not longer than 10 years. It is therefore important that all actors in the system, including aerodrome operators, the wider aviation sector and local authorities are proactive and ensure that the growth in aerodrome capacity is appropriately integrated within these plans. Land use controls need to include restrictions on incompatible use or activities and potential obstacles or hazards that could impact the safe and efficient operation of aircraft. Appropriate objectives, policies and rules in both regional and district Plans are required.

The main components to be considered are:

- Protection of obstacle limitation surfaces
- Protection of new and modified aircraft arrival and departure paths, determined in collaboration with airline and air traffic service providers
- Integration with airspace designation and planning
- Noise emissions, including mitigation of the effects of aviation activities on communities
- Wildlife hazard management strategies in relation to the airport environs and flight arrival and departure paths
Contingency

The critical connection with other parts of the air traffic management system means that capacity planning will need to take into account disruption to the overall ATM system.

A challenge for all planners is integrating the needs of all users, and people affected by planning decisions. Operators are part of a collaborative partnership incorporating the regulator, air traffic service provider, and aircraft operators in determining future capacity requirements. One of the unique features of many of New Zealand’s aerodromes that will need to be addressed is the range of different aircraft types and operations that use the aerodrome facilities.
PLAN FOR AERODROMES

Stage 1 (2015): Establish collaborative decision making forums and ensure effective contingency plans are in place

Stage 2 (2018): Policy developed on Aerodrome critical infrastructure and contingency needs for New Zealand

Stage 3 (2023): All Aerodrome master plans should take into account the objectives and actions set out in the National Airspace and Navigation Plan

Objectives

Q Master plans for aerodromes should include the following features:

- increase aerodrome capacity by utilising collaborative decision making
- take into account the need for integration with other aspects of the ATM system, land-side operations and interaction with land-use planning
- achieve all-weather throughput at as close to the levels of visual throughput as possible.
- improves the predictability of movements based on shared information
- specifies the infrastructure needed (surveillance tools, visual aids, approach types, lighting and geometry required) depending on the demands and needs of the system
- ensure that appropriate contingency plans are in place that reflect a network management approach

Q Critical Airports: Review terminal and airfield design/geometry

- identify constraints to reduced runway occupancy times or aircraft movement capacity
- establish a roadmap for capacity enhancement to forecast industry capacity demands

Q Policy developed on airport infrastructure needs for New Zealand

Q Establish a formalised airport collaborative decision making forum

Q Review critical infrastructure and systems to identify areas where further contingency measures are required to provide an industry-agreed level of resilience

Principles

Q Aerodrome operators should aim to work collaboratively with their aviation partners in the timely provision of sufficient aerodrome capacity through infrastructure and systems, ensure compatible land use planning for surrounding land, and contribute to airspace management that will provide the capability to operate in all weather conditions, while ensuring resilience in the provision of aerodrome services.
## Aerodrome Actions

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Establish collaborative decision making forums and ensure effective contingency plans are in place.</td>
<td>Policy developed on Aerodrome critical infrastructure and contingency needs for New Zealand</td>
<td>All Aerodrome master plans should take into account the objectives and actions set out in the National Airspace and Navigation Plan.</td>
</tr>
<tr>
<td>All Aerodrome master plans should align with the objectives and actions set out in the National Airspace and Navigation Plan</td>
<td>All Aerodrome master plans should take into account the objectives set out in this Plan.</td>
<td></td>
</tr>
<tr>
<td>Aerodrome Collaborative Decision Making Forum</td>
<td>Aerodrome Collaborative Decision Making Forum established.</td>
<td>All International aerodromes to establish collaborative decision making.</td>
</tr>
<tr>
<td>Critical Airports:</td>
<td>Review terminal and airfield design/geometry and identify constraints to reduced runway occupancy times or aircraft movement capacity. Establish a roadmap for capacity enhancement to forecast industry capacity demands.</td>
<td>Policy developed on support required for critical aerodrome infrastructure in New Zealand.</td>
</tr>
<tr>
<td>Policy developed on Aerodrome critical infrastructure and contingency needs for New Zealand</td>
<td>Review Aerodrome contingency plans to ensure an industry-agreed level of resilience.</td>
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</tbody>
</table>
INTRODUCTION

Meteorological services, including warnings, forecasts, observations and delivery systems, are an essential component of national and international aviation operations, contributing to safety and efficiency.

Communication and integration of meteorological information into air traffic management systems aeronautical information systems and, in particular, performance-based navigation applications will be an essential for the implementation of a globally interoperable, seamless ATM system.

INTERNATIONAL DEVELOPMENTS

Internationally, changes to the provision of meteorological information will be based on the integration of meteorological and ATM information to support operational decision-making. This direction was confirmed at the ICAO 12th Air Navigation Conference in November 2012, and is outlined in the Global Air Navigation Plan (Table 8).

The Conference noted that meteorological information was an integral component of the future system-wide information management (SWIM) environment, alongside aeronautical information, flight and flow information and other information sources. This would enhance the safety and the efficiency of the global ATM system enhanced through availability and use of meteorological information.

The concepts for Global Air Traffic Management (ATM) and Performance-based Navigation (PBN) are well documented in:

- Global ATM concept in ICAO Doc 9854 “Global Air Traffic Management Operational Concept”
- ICAO Doc 9882 “Manual on Air Traffic Management System Requirements”
- Air Traffic Management Requirements Performance Panel (ATMRPP) document “Flight and Flow Information for a Collaborative Environment” (FF-ICE)

However all of the above documents currently only mention or reference “weather” (meteorological services) in general terms. The documents do not as yet specify the particular meteorological services required for global ATM and PBN.

Despite the lack of international clarity, meteorological information is already being integrated into Flight Management Systems and is expected to be factored into ATM Decision Support Tools (DSTs) and airline Safety Risk Assessments (SRAs) to mitigate risk and support safe and efficient flight operations, especially where airspace and aerodromes are congested or capacity constrained.

This will enable best-trajectory services/operations by formulating the most efficient air traffic routing and flight profile solutions that will continuously account for dynamic meteorological conditions and phenomena. DSTs and SRAs should allow end users to make structured decisions based on the impacts of meteorological conditions, rather than relying on interpretations of meteorological information.

DSTs are envisaged as software applications used to automate meteorological impact evaluations and ATC operator/user response. DSTs will fuse meteorological information with other relevant information such as aeronautical information and flight planning information. DSTs will not only use meteorological information but will fuse this information with other relevant information such as engineering data, operations management information, and aeronautical and flight planning information, to support better information-based decision making.

Meteorological services for general aviation will be increasingly shaped by international developments. New meteorological requirements that are adopted for airlines and ATM may flow through to flight training, smaller commercial operators and the recreational general aviation sector. However, general aviation may require current legacy products to continue in the short term.

It is also expected that users will require more use of probabilistic forecasts in the future to enable decisions formally predicated on agreed pre-determined thresholds.
## TABLE 8: ICAO BLOCK UPGRADES RELATED TO METEOROLOGY

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<thead>
<tr>
<th>Block 0</th>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
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<tbody>
<tr>
<td>AMET</td>
<td>Enhanced Operational Decisions through integrated Meteorological information (Planning and near term service)</td>
<td>Enhanced operational decisions through integrated meteorological information (Near term and intermediate service)</td>
<td></td>
</tr>
<tr>
<td>Meteorological information supporting enhanced operational efficiency and Safety</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Aerodrome warnings to give concise information</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Forecasts provided by world area forecast centres, volcanic ash advisory centres and tropical cyclone advisory centres.</td>
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<td></td>
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<tr>
<td>Supports flexible airspace management, improved situational awareness and collaborative decision making and dynamically optimised flight trajectory planning</td>
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## STATUS OF NEW ZEALAND METEOROLOGICAL SERVICES

Annex 3 to the 1944 Chicago Convention on International Civil Aviation (the Convention - administered by International Civil Aviation Organisation - ICAO) defines the basic meteorological services required for international air navigation. These services are designed to contribute towards the goals of safety, regularity and efficiency of international aviation.

Annex 15 to the Convention defines the subset of meteorological services required for State aeronautical information service to ensure the flow of information/data necessary for the safety, regularity and efficiency of international air navigation.

The CAA is designated by the Minister of Transport as the National Meteorological Authority.

The CAA contracts the Meteorological Service of New Zealand Ltd (MetService) to meet operational Annex 3 requirements for international aviation. MetService has certification under Civil Aviation Rule (CAR) Part 174 and provides five of the six service categories (it does not provide a climatology service). An important aspect of this is the provision of Meteorological Watch Office and Volcanic Ash Advisory Centre operations through MetService.

Airways Corporation is certificated under CAR Part 174 (partial certification), to supply meteorological information. Airways also provides, under its CAR Part 171 certification, the current aeronautical fixed telecommunications system for the distribution of meteorological information to the aviation system.

The CAA regulates the provision of meteorological services in New Zealand through the certification, approval, and monitoring of organisations.

The objective of the CAA’s oversight of MetService and Airways Corporation provision and communication of meteorological information is to ensure that sufficient, standard-compliant, information and data necessary for the safety, regularity and efficiency of air navigation within the New Zealand Oceanic and Domestic Flight Information Regions (FIRs), is constantly available.

Currently the CAA and New Zealand is represented on the ICAO Meteorological Aeronautical Requirements and Information Exchange Project Team (MARIE PT) working to a brief from the ICAO Aerodrome Meteorological Observation and Forecast Study Group (AMOFSG).

MARIE PT is established to support the MET secretariat in a number of activities related to MET information Exchange and MET information support to ATM. Specifically it is charged with developments for the introduction of XML/GML to replace traditional alphanumeric codes (TACs) including METAR, SPECI, TAF, and SIGMET. Areas not covered by MARIE PT include the translation of WAFS information (GRIB2 data and SIGWX charts).

MARIE PT works closely with the WMO who are responsible for scientific and coding support to ICAO meteorological endeavours.
### TABLE 9: EXISTING METEOROLOGICAL PLANS

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Plans for Met Service</th>
<th>Delivery Mechanisms</th>
</tr>
</thead>
</table>
| 2013-2018 | Implementation of ICAO AMD 76 wef 14 Nov 2013  
Implementation of ICAO AMD 77 wef 14 Nov 2016  
Deliver Text and Graphics in XML (Extensible Mark-up Language) and GML (Geographic Markup Language) starting in 2014.  
Test and plan for implementation of conceptual and exchange models and associated formats that are highly applicable to ICAO standards, and in particular ICAO Annex 3 starting in 2014.  
(The models should include conceptual and exchange representations of AIRMET, AIREP, AMDAR, CCFP, G-AIRMET, SIGMET, METAR, PIREP, VAA, MDCR, and TAF. They should also include representations for weather information types such as wind shear, contours, gust fronts, motion vectors, grids, points, trajectories, profiles, swaths, and sections). | Self-Managed internet based systems  
Direct feeds to Airline FOCs  
FTP server  
Webpages  
Webcams  
Email  
Faxing  
AFTN/AMHS  
Application agnostic delivery channels for tablet devices and smart phones |

### CHALLENGES FOR NEW ZEALAND

#### Funding and resourcing

Internationally, some of the concepts being implemented in major regional ATM modernisation programmes require a significant investment in both resources and technology, and will be difficult for some States of the Asia-Pacific region to implement. The use of older text format messages by some in a progressively digital environment will likely require duplication of delivery and processing systems for meteorological information in the short term.

A phased, gradual approach to technology up-take and its operational implementation will be required. Users of meteorological information will vary in their ability to transition to new meteorological products and technologies, and consideration should be given to the extent to which legacy systems may need to be retained to support the transition, as well as to avoid reliance on a single technology in the longer term.

The needs of users in the broader operating environment outside of New Zealand airspace should be considered in order to achieve, where practicable, a closer alignment with ICAO’s vision of an integrated, harmonised and globally interoperable ATM system.

General aviation (GA) users will have particular requirements that will be the focus of future work.

Regionalisation of hazardous weather information and data, and possibly the production of aerodrome meteorological forecast information is highly likely. Under such a regime New Zealand will probably need to take on regional responsibilities for a large part of the South Pacific. This will have resource and cost implications.

There is currently no government funding for the provision of meteorological services for aviation in New Zealand. In the near term, the cost of providing services will continue to be recovered on a commercial basis with regard to legislation, under the state-owned enterprise (SOE) model and, where appropriate, charging guidelines issued by ICAO. Alternative means of recovering costs of meteorological services from the aviation sector will continue to be assessed on the basis of utility, equity, and responsiveness.

#### ICAO Meteorological Specifications

ICAO, through its various working groups, has not yet specified the meteorological services required for global AIS, ATM and PBN; these services are currently at a conceptual stage. On the other hand, ICAO has documented, in detail, the concepts for global AIS, ATM and PBN. Although many of these documents mention or reference “weather” (meteorological services) in general terms, they do not yet specify the meteorological services required.
**Conflicting products**

Real-time meteorological data streams could be provided mitigating the risk of potentially conflicting and perishable meteorological products. Such a network-enabled provision of meteorological information would support common situational awareness amongst ATM and operators.

**Sources of weather data**

In New Zealand, most current weather support to AIS, ATM, AIS and aviation users is provided for use by individuals such as pilots, air-traffic controllers, traffic managers, and dispatchers. Transitioning from this approach has several challenges:

- Some weather products do not have the maturity required for direct insertion/integration without interpretation nor are they currently able to be translated into impact information.
- Rules for interpretation and use of weather data are generally based on the experience of the user and/or the level of technology available.
- ATM decisions based upon current meteorological information/products are inconsistent from user to user.

**Implementation risks**

Implementation risks are associated with the following:

- Matching of meteorological capabilities with the capability of well-equipped airline FOCs to transmit data to/from cockpits, including those of less well-equipped airline FOCs and other users.
- The capability of airline FOCs and users to receive and/or utilise updated meteorological data in-flight to accommodate flexi-route operations.
- Continued use of older text format messages by less well-equipped airline FOCs and users, in a progressively digital environment will probably require duplication of delivery and processing systems for meteorological information.

**Legislative mandate**

There is currently no legislated requirement for any New Zealand organisation to provide meteorological services for domestic aviation. However there are requirements for air operations under CAR Parts 121, 125, and 135 for meteorological information to be used for a flight sector originating within New Zealand provided by a holder of an aviation meteorological service organisation certificate issued in accordance with Part 174.

The existing designation of the CAA as the Meteorological Authority is enacted through Ministerial delegation of this responsibility from the Chicago Convention, and only applies to international aviation.
PLAN FOR METEOROLOGY

Stage 1 (2015): Develop IWXXM format for weather
Stage 2 (2018): Integration of weather data with aeronautical information
Stage 3 (2023): Weather into cockpit, real time

Objectives

- Meteorological information products to be in extensible markup language (XML) or geographic markup language (GML) formats
- Develop information exchange standards to ensure interoperability within New Zealand and the Asia-Pacific region that are linked with other aviation data domains.
- Replace the use of individual meteorological products, with network-enabled consistent meteorological information supporting common situational awareness. This approach should cover the full set of products
- Integrate meteorological information into aircraft operation systems including glass cockpits, Electronic Flight Bags (EFBs) and portable carry on devices such as iPad, as well as operator safety risk assessments, ATM and AIS decision support systems.
- Integrate meteorological information into aeronautical information management data, aiming for meteorological information streaming to flight operation centres, ATM/AIS/PBN and aircraft cockpit.
- Decision Support Tools provided to ATM and PBN to deal with meteorological information and translate it into constraints and impacts on ATM and PBN.
- Greater use of probabilistic forecasts, to enable users to make decisions based on their own pre-determined thresholds.

Principles

- Future MET/ATM/PBN systems should promote the sharing of real time meteorological information
- All interpretation and translations of meteorological information will need to be automated and objective.
- Keep pace, and maintain alignment, with international development
- Characterisation of meteorological forecast uncertainty is a key precept of MET/ATM/AIS/PBN engagement.
- Intensities and rates of forecast and observed meteorological conditions will need to be expressed as indexed values that can be calibrated according to aircraft type, rather than characterised as light, moderate or severe without regard to the aircraft type.
- Future meteorological support provided for New Zealand aviation should be designed to minimise the impact of weather on the air transport system within New Zealand’s areas of responsibility.
- World-wide collaboration is key to effective and integrated meteorological services
## Meteorology Actions

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<thead>
<tr>
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<tbody>
<tr>
<td>METAR AUTO instrumentation implemented at all domestic, military and international aerodromes.</td>
<td>Radar imagery from full network available to ATM centres and ATC Tower controllers.</td>
<td>METAR AUTO instrumentation implemented at all domestic, military and international aerodromes.</td>
<td>Radar imagery from full network available to ATM centres and ATC Tower controllers.</td>
</tr>
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<td>Implementation of GRIB2 data feed from WAFC</td>
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<td><strong>Navigation</strong></td>
<td>Continued use of legacy navigation applications while PBN capability is progressively implemented in aircraft fleets and the supporting infrastructure. The ground infrastructure associated with legacy navigation systems will be reviewed and progressively adapted</td>
<td>Move to a more exclusive PBN environment that places greater reliance on the level of PBN capability in the national fleet and infrastructure. The ATM system will be managing a more homogeneous navigation capability</td>
<td>A mature PBN environment with a comprehensive fleet and infrastructure capability. Air traffic management tools complement airborne systems and enable the management of those aircraft that may experience temporary loss of PBN capability. Contingency ground infrastructure that enables all aircraft to safely return to the ground</td>
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<td><strong>Surveillance</strong></td>
<td>Planning for progressive implementation of ADS-B, including rule development and training and education programme development</td>
<td>ADS-B exclusive airspace above FL 245 with supporting network of ADS-B receivers</td>
<td>ADS-B exclusive in all controlled airspace. Some provision for back-up ground surveillance network and special areas for non-ADS-B equipped aircraft.</td>
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<td><strong>Communications</strong></td>
<td>On-going maintenance of the VHF network. Make transition from AFTN to AMHS. Develop policy for Remotely Piloted Aircraft communications</td>
<td>International pre-departure clearances via data-link. Review demand for additional use of Data-link technology. VDIP for ground and remote communications. Implement Remotely Piloted Aircraft Policy</td>
<td>VHF communication remains the primary means of domestic communication. Approve SATVOICE as a primary means of communication in oceanic controlled airspace. Implement results of review on Data-link technology. Transition to ATN protocol.</td>
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<td><strong>Information</strong></td>
<td>Going digital: transition from AIS to AIM in accordance with ICAO roadmap</td>
<td>Information Management – system integration through common data standards and communications</td>
<td>Real time availability of aeronautical information and data into aircraft</td>
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<td>Infrastructure, procedure and tool development towards trajectory based management including education programmes</td>
<td>Implementation of trajectory based management tools, training programmes</td>
<td>Trajectory based management in place supported by integrated information and collaborative processes</td>
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<td><strong>Airspace Design</strong></td>
<td>Review existing designations and develop methodology and triggers for future reviews</td>
<td>Full review of NZ airspace to be completed by this time</td>
<td>Revised airspace in place, review options for transponder mandatory in uncontrolled airspace and for reduced need for control areas with greater use of aircraft self-separation</td>
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<td><strong>Aerodromes</strong></td>
<td>Establish collaborative collaborative decision making forums and ensure effective contingency plans are in place</td>
<td>Policy developed on Aerodrome critical infrastructure and contingency needs for NZ</td>
<td>Aerodrome master plans have regard to objectives and actions set out in the Plan</td>
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<td><strong>Meteorological</strong></td>
<td>Develop WXXM format for weather reporting</td>
<td>Integration of weather data with aeronautical information</td>
<td>Real time availability of Weather data into aircraft</td>
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<td><strong>Services</strong></td>
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## Navigation Actions

|----------------------------|-----------------------------------------------|---------------------------------------------------------------|
| Implement PBN routes to enable progressively greater dependence on PBN – initially to support key routes for larger operators and ultimately aiming for a sole-means GNSS navigation environment. | RNAV 10 and RNP 4 in Oceanic airspace.  
RNAV 2 for routes.  
RNAV 1 for all terminal routes with surveillance services and basic RNP 1 for routes without surveillance services.  
At least one ground based instrument approach procedure retained for each main runway end at controlled aerodromes. | RNP 2 in routes above FL 145  
RNP APCH (RNAV GNSS) with APV where possible and RNP AR APCH as required.  
Includes Helicopter routes.  
All routes (including SIDs and STARs) will be enabled by RNAV (or RNP, where required). All runway ends with instrument approach procedures will be enabled by RNP (with APV where possible based on Baro-VNAV). |
| Develop and implement a clear strategy to identify which ground navigation aids should remain in place as a contingency in case of emergencies and equipment failures. | Develop Navigation Aid Contingency Strategy using a consultative process  
Q in case of a GNSS outage, all airborne aircraft can be safely recovered  
Q continuity of service can be maintained on the main trunk routes  
Q Retain ILS at major international airports and their alternates | Decommissioning of some terrestrial navigation systems in accordance with Navigation Aid contingency strategy  
Navigation Aid contingency network in place |
| Equipment, Operator and Training requirements for PBN to be implemented as detailed in Advisory Circular AC 91-21 Rev A | Operators wishing to use promulgated PBN Routes to comply with equipment, procedure and training specifications in Advisory Circular AC91-21. | All IFR operators to be approved for PBN navigation |
| Guidance and education for operators to make the transition to a PBN environment | Develop guidance and education programme for affected operators, pilots and air traffic controllers | Implement guidance and education programme |
| Training standards revised for pilots flying PBN routes | IFR training standards updated | IFR training standards promulgated |
| Ensure that the policy and regulatory framework supports the changes | Revoke Part 19 GPS rules and replace with new operational rules  
Complete analysis on “sole use” navigation for domestic IFR flight | Review requirements for Satellite Based Augmentation System |
## Surveillance Actions

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<tr>
<td>Planning for progressive implementation of ADS-B</td>
<td>ADS-B mandatory airspace above FL 245 and CTA or major international airports</td>
<td>ADS-B mandatory in all controlled airspace. Back-up ground surveillance network in place as per contingency plan</td>
</tr>
<tr>
<td>Develop a strategy for decommissioning the radar network by 2021 ensuring that an adequate network of back-up surveillance remains in place</td>
<td>Contingency plan developed to ensure fail-safe surveillance system</td>
<td>Contingency plan implemented</td>
</tr>
<tr>
<td>Develop rules to allow progressive implementation of ADS-B airspace</td>
<td>Rule development – timelines and specifications for equipage and operator requirements</td>
<td></td>
</tr>
<tr>
<td>Install network of ADS-B receivers to replace radar network</td>
<td>ADS-B ground infrastructure in place to provide coverage above FL245</td>
<td>ADS-B ground infrastructure provides coverage of all controlled airspace</td>
</tr>
<tr>
<td>Require ADS-B equipment to be installed on aircraft in a staged way</td>
<td>Approved ADS-B transponder required in all aircraft operating above FL245.</td>
<td>Approved ADS-B transponders required in all controlled airspace</td>
</tr>
<tr>
<td>Implement an education programme for operators, pilots and air traffic controllers on future ADS-B installation and operational requirements</td>
<td>Operator procedure guidelines developed</td>
<td>Training requirements for use of ADS-B equipment included in training curriculum</td>
</tr>
<tr>
<td>Education programme for operators, pilots and air traffic controllers on ADS-B installation, and operational requirements.</td>
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<tr>
<td>Training standards updated</td>
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<tr>
<td>Ensure adequate capacity to assess and issue approvals for aircraft, operators and pilots</td>
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### Contingency Plan

- Ensure that in case of a GNSS outage, all airborne aircraft can be safely recovered
- Ensure continuity of service can be maintained at international airports and on the main trunk routes
- Make provision for some controlled airspace to be designated for transit lanes and special areas for non-ADS-B equipped aircraft

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### Training Requirements

- Training requirements for use of ADS-B equipment included in training curriculum
- Review of technologies, including multistatic primary surveillance radar and options for self-surveillance using ADS-B IN.
## Communication Actions

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<td><strong>Business as usual</strong></td>
<td>Business as usual, with a transition from AFTN to AMHS</td>
<td>Introduction of some new protocols, methods and technologies</td>
<td>Transition to ATN</td>
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<tr>
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<td>Review demand for data-link technology in domestic airspace</td>
<td>Accept SATVOICE for primary communications</td>
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<td>Implement results of review on data-link technology</td>
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<tr>
<td><strong>Communications policy for Remotely Piloted Aircraft</strong></td>
<td>On-going maintenance of the VHF network</td>
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<td>Additional options for Oceanic airspace aircraft equipped with FANS1/A data-link.</td>
<td>Enable aircraft to use HFDL as a back-up.</td>
<td>Implement Baseline 2 (using ATN) to implemented in parallel with FANS 1/A.</td>
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<td>On-going maintenance of the VHF network</td>
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<td><strong>Develop new protocols</strong></td>
<td>Complete transition from AFTN to AMHS</td>
<td>Implement ATN</td>
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<tr>
<td><strong>Introduce and review demand for additional communication methods—SATVOICE and Data-link</strong></td>
<td>Complete transition from AFTN to AMHS</td>
<td>International Pre-departure clearances via data-link (ARINC 623) from 2014</td>
<td>Oceanic: SATVOICE supersedes HF as primary voice system</td>
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<td>Review demand for data-link in the domestic environment—including for:</td>
<td>Implement results of data-link reviews</td>
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<td>Q Aerodrome Mobile Airport Communication System (Aeromacs) data-link system</td>
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<td>Q L-Band Data-link Aeronautical Communications (LDACS) technology</td>
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**Aeronautical Information Actions**

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<td>Integration of data and systems</td>
<td>Real time availability of data into aircraft</td>
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- Start digitalization of remaining information domains in accordance with the ICAO roadmap
  - P-08 — Aeronautical information conceptual model (AICM)*
  - P-14 — Obstacles
  - P-15 — Aerodrome mapping
  - P-09 — Aeronautical data exchange
  - P-10 — Communication networks
  - P-12 — Aeronautical information briefing
  - P-16 — Training
  - P-18 — Agreements with data originators

- Ensure information management is integrated in accordance with ICAO roadmap
  - P-20 — Electronic aeronautical charts
  - P-19 — Interoperability with meteorological products
  - P-21 — Digital NOTAM

- Make digital aeronautical data accessible to all participants in the system
  - Real-time availability of some aeronautical information
  - Real-time availability of data to the aircraft

- Manage human factors associated with data availability
  - Assess implications of growing use of devices (smartphones, i-Pads etc) in aircraft and review regulatory requirements
  - Education programme on future information systems - includes use of devices and applications to access information
## Air Traffic Management Actions

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### Further develop tools—taking into account the needs of end users
- Development of trajectory based management and network management tools for Air Traffic Controllers
- Network-wide management principles and agreements in place
- Implement hardware and systems for trajectory based management
- Virtual air traffic control testing
- Virtual air traffic control in place at selected locations

### Incorporate all ground and airborne aspects
- Ensure that ATM systems cater for developments in the other Plan elements

### Ensure that there are adequate contingencies to enable management during failures in the Air Traffic Management System
- Contingency plan for Air Traffic Management emergency situations amended given introduction of new management systems

### Educate, train and encourage all users (controllers and operators) to operate within the developing environment
- Education programme on upcoming changes to air traffic management
- Human factors assessment to ensure transition to time based trajectory management and full network management complexities are fully assessed

### Develop a performance framework
- Develop a set of metrics that will provide a measure of performance of the various aspects supporting Air Traffic Management
- Review of performance of Air Traffic Management System
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### Airspace Design Actions

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<td>Full review of NZ airspace</td>
<td>Ongoing review of airspace impacts from new technologies</td>
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<td>Develop triggers and methodology for airspace reviews to take into account milestones and significant changes in activity</td>
<td>Develop triggers and methodology for future airspace reviews Define the methodology in guidance documents, including consultation requirements.</td>
<td>Full review of NZ airspace based on the methodology.</td>
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<td>Reassess provisions relating to transponder requirements –</td>
<td>With the introduction of ADS-B, review transponder mandatory airspace requirements</td>
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<td>Consider whether there should be any variations to airspace rules and procedures</td>
<td>Review airspace provisions relating to emergencies and civil emergencies taking changes in navigation, surveillance and air traffic management changes into account.</td>
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All Aerodrome master plans should align with the objectives and actions set out in the National Airspace and Navigation Plan.

Aerodrome Collaborative Decision Making Forum

Aerodrome Collaborative Decision Making Forum established.

All International aerodromes to establish collaborative decision making.

Critical Airports:

Review terminal and airfield design/geometry and identify constraints to reduced runway occupancy times or aircraft movement capacity.

Establish a roadmap for capacity enhancement to forecast industry capacity demands.

Policy developed on support required for critical aerodrome infrastructure in New Zealand.

Policy developed on Aerodrome critical infrastructure and contingency needs for New Zealand.

Review Aerodrome contingency plans to ensure an industry-agreed level of resilience.
## Meteorology Actions

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<td>METAR AUTO instrumentation implemented at all domestic, military and international aerodromes.</td>
<td>Radar imagery from full network available to ATM centres and ATC Tower controllers.</td>
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