International Civil Aviation Organization

Sith Meeting of the Asia/Pacific Air Traffic Management Automation System Task Force (APAC ATMAS TF/6)

Bangkok, Thailand, 2-4 June 2025

Agenda Item 5: ATM Automation System Implementation Experience by States

5.1. Resilience consideration and contingency planning

NEW ZEALAND APPROACH TO ATMAS DEVELOPMENT RESILIENCE

(Presented by New Zealand)

SUMMARY

Airways Corporation of New Zealand (Airways) is relatively unique in managing its own ATMAS development. Airways has pursued this approach due to New Zealand's ATM specific needs and a desire to obtain greater control of ATMAS management to meet those needs. With significant effort, Airways has obtained a high degree of development independence and benefits from enhanced development capability, resilience, and lifecycle management. The paper provides an overview of Airways' approach, results, and considerations in developing greater ATMAS independence.

1. INTRODUCTION

1.1 Airways is the ANSP for the NZZC and NZZO FIRs that respectively encompass New Zealand's Domestic airspace and a significant portion of the South-West Pacific's oceanic airspace.

1.2 Airways' relatively small size, its corporate requirements, New Zealand's location and airspace needs put specific demands on any Air Traffic Management Automation System (ATMAS) solution.

1.3 With the demands of ATMAS management, Airways chose a path which gave the company the authority and flexibility in ATMAS management it required, to meet the environment's needs and provide safe, efficient, and cost-effective ATS.

1.4 The approach undertaken by Airways is described in this paper along with the results and considerations around such an approach.

2. DISCUSSION

<u>Factors Influencing Airways Approach to ATMAS Life Cycling and Management</u>

2.1 New Zealand is a geographically remote country that relies on aviation for connectivity with the rest of the world. The country has 30 million square kilometers of airspace divided into two FIRs as shown below. Airways is the national ANSP and tasked with the continuous provision of safe, efficient, and cost effective ATS for the airspace delegated to New Zealand.

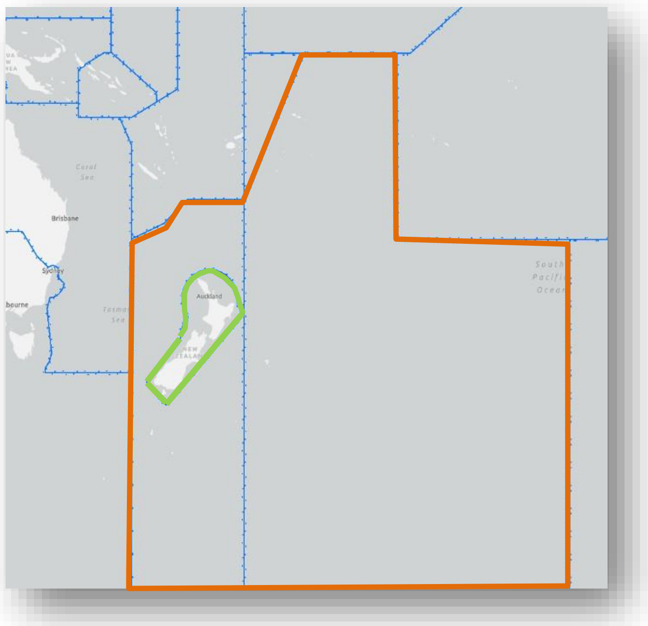

Fig. 1. NZZO (Orange) and NZZC (Green)

2.2 As the responsible, yet relatively small ANSP, Airways must respond effectively to the needs of its ATM environment. Any ATMAS solution is a critical part of that response. Specific needs that directly affect ATMAS management are:

- **Domestic FIR –** The airspace has a wide range of airspace users from general aviation to airlines and military, through to new airspace entrants. Traffic levels can be relatively high and complex due to the mix of users. With 17 ATC provided airports to connect, this environment requires mature CNS with nationwide VHF communications, ADS-B based surveillance and a PBN route structure. A mature and reliable ATMAS that can utilize the CNS capabilities of the system to effect safe and efficient ATS is essential.

- **Oceanic FIR –** The airspace predominantly services well-equipped long-range air transport operations but encompasses areas of varying CNS capability, from none (across large swathes of the Pacific Ocean) to mature (across Pacific States). To provide the most effective oceanic control services, the environment requires an ATMAS optimised for GNSS navigation, ADS-C surveillance, and CPDLC communications – ideally with a high level of system support in separation determination and inter-FIR co-ordination.

- **Regulatory/Corporate structure -** Airways is a State-Owned Enterprise (SOE), owned by the New Zealand Government but run as a commercial entity. The company funds all its Business as Usual (BAU) operations (including ATMAS procurement and management) via airspace user charges. Airways is expected to provide safe, reliable, and cost-effective ATS, that responds to air space user needs and regulatory / technological initiatives effectively. ATMAS procurement / management can be very expensive, and Airways is required to seek value when conducting procurements.

- **Service Availability –** ATS is a crucial service for New Zealand and interruptions can have significant economic and social impact. ATMAS availability is a critical element for ATS provision and the ability to design and respond effectively to events that may impact ATMAS availability is essential.

2.3 Since becoming an SOE in the late 1980s, Airways has evolved its ATMAS management capability to overcome challenges encountered in meeting its environmental needs, namely:

- **Change Management –** Initially, given our location relative to vendors and the relative difficulty in coordinating change from such distances, responsiveness could be compromised. As a result, desired enhancement could be costly and potentially lead to deferral of development. Enhancement cycles were AIRAC based and build implementation was operationally disruptive to conduct.

- **System Expandability –** With FANS becoming operational, Airways wanted to automate (its then) procedural oceanic service. Additionally, for the domestic ATMAS, evolving technologies such as GNSS, datalink and ADS-B indicated a future where technology change would require the system to have a 'continuous development' capability.

- **Automation of workload –** The development of support tools to overcome workload or monitoring capacity limits or enhance safety became increasingly important as traffic levels grew. Concepts such as RVSM and PBN introduced eligibility and compliance complexities into flight handling. Airways desired a more responsive way to capture and implement change that would effectively work for New Zealand's airspace users as airborne technology matured.

- **Life–cycling –** Although reflective of the technology of the time, as systems aged, obtaining components became increasingly difficult and could have impacted service availability. Rehosting options were also limited. As technology evolved, Airway's desire to move to a continuous development approach included life-cycling, ideally with systems being hardware/operating system agnostic and managed through upgrade cycles that mitigated nominal system lifespan expectations.

- **Resilience –** With the evolution of ATMASs, and more generally, computing technology through the 90s, Airways sought cost-effective solutions to system failure scenarios. Ideally, solutions would provide the desired level of availability but avoid the costly duplication of ATMAS that a State could otherwise feel was required to meet availability of service requirements. Airways also sought to reduce the risk that came with larger infrequent releases and the degree of change such cycles could cause in operations.

2.4 The identified ATMAS management challenges led the company to seek solutions that gave it the control it required. The solutions chosen required significant investment by Airways and an evolutionary approach that, from the 1990's, continues today.

Evolved Approach to ATMAS Management

2.5 Starting with the Airways Modernisation Program (AMP) and implementation of a Thales AIRCAT system in 1991, Airways began to take a more proactive role in its system management. Though the system was procured via a traditional RFI/RFP process, essential to its selection was Airways learning and then managing functional development (requirements, software development, validation and implementation). This approach led to the creation of the initial Airways' Requirements and Software teams, and most development being conducted by those teams with vendor support.

2.6 The next major step was the replacement of procedural oceanic control with the Oceanic Control System (OCS) in the 1990s. The RFP process resulted in an award to CAE Electronics Ltd., that included long term conflict detection (LTCD). LTCD enhances the controller's ability to manage separations and allows controller directed profile management via the HMI.

2.7 The results of the OCS procurement led to the creation of the distinct OCS Requirements and Software teams, a system that has been in operation for 25 years, and autonomous management of system enhancement and life-cycling. (Airways assumed responsibility for independently maintaining and enhancing the OCS system once it transitioned into live operation.)

2.8 Next was implementation of SkyLine, a new Domestic ATMAS, in the early 2000s. Leveraging its in-house capabilities further, Airways now sought a partnership approach to this procurement. Partnership being - Airway's operational, software and systems SMEs working side-by-side with the vendor equivalents on a New Zealand orientated design. Iterative development builds would be tested, fine-tuned, and operationally validated on a development system based in New Zealand with all development phases, from unit testing through FAT/SAT, conducted there too.

2.9 SkyLine went live in 2003 and remained in operation until 2023. In 2016 Airways began looking for a replacement system – again with the emphasis on partnership but with greater autonomy as our in-house capability had evolved over the intervening 20 years. This led to the selection of Leidos's SkyLine-X, with enhanced capabilities as described in a previous ATMAS TF (TF/4 IP8).

2.10 The essential elements Airways progressed over the timeframe outlined above were:

- **In-house capability -** to provide the responsiveness and resilience desired of its ATMASs and support effective development, Airways has evolved its in-house capability to include the following dedicated teams:
  - Domestic and Oceanic Requirements – A distinct team for each ATMAS, they update adaptation, triage issues, and convert operational needs into functional requirements, then write test cases and validate enhancements.
  - Domestic and Oceanic Software development – A distinct team for each ATMAS, they conduct software development of their respective systems based on functional or technical requirements or identified issues. The teams also carry out system upgrades, interface, and architecture design management.
  - Systems Engineering – This team designs and implements ATMAS physical infrastructure, the connectivity of system components or systems to systems.
  - Network Management – This team designs, develops and manages the national network that connects Airways CNS architecture with Tower and Centre systems. The team works with national network infrastructure providers and system vendors to ensure the required level of availability from the network.

- **Processes/infrastructure -** to support a safe and effective development process, Airways has established and evolved the following:
  - Safety Management System approach to risk identification, mitigation/management.
  - Documentation of Requirements capture, software development, and testing/release processes.
  - Investment in tools for needs/requirements specification, issue/enhancement management, build creation/release and test casing/results coverage.
  - Development of user-oriented HMI-based adaptation interfaces.
  - Physical labs to support effective testing. Both ATMAS have labs that mirror their live system equivalent (positions and systems) and can be fed live or simulated ATM data to support testing/validation from unit through to system wide functional change and operational build regression.
  - Virtualised labs – These allow teams to configure environments specific to their needs and support continuous development away from the labs. Such labs provide alternative capability if physical labs are unavailable due to formal test phases, requirement for testing other ATM elements, or maintenance.
  - Quality Assurance capability across software, requirements, and systems processes to support process adherence and improvement.
  - Regular external audit of processes (by both ISO and CAA New Zealand)
  - Progress towards DO-278A conformance in its software development processes.

- **Partnerships –** As its capabilities grew, Airways procurement requirements reflected the degree of autonomy in development the company had with the desired result of any vendor selection to give Airways greater control of:
  - ATMAS specification and procurement
  - Functional specification orientated to the New Zealand environment.
  - System functional development and implementation management
  - System engineering including design, validation, and implementation.
  - Overall system-of-systems oversight and risk management
  - The life cycle cost of ATMAS management

<u>Results</u>

2.11 The best determinant of the success of Airways' approach is to assess how well it has mitigated the challenges the company faced. Each challenge is considered below:

- **Change Management**
  - Since implementation, both ATMAS conduct build releases every AIRAC cycle (nominally 8 weeks). Each release contains:
    - AIP published changes (primarily adaptation)
    - Minor/major functional enhancements including Sector/TWR specific changes (adaptation and/or software)
    - Issue resolution (adaptation or software)
    - Scheduled project level changes.
  - System releases may contain any number of functional enhancements, issue resolutions, and adaptation changes. The number and type of changes vary based on factors including adaptation/software load balance, project schedules or team workloads.
  - Significant project-based enhancements can be scheduled as required, with continuous development through build cycles. In development, functionality

can be worked on through the development phase of each cycle and then 'switched off'[1] for an operational build so that formal testing can be conducted before the release. After the release the functionality can be 'switched on' for the next development build.
    - Intermediary releases can be conducted for off-cycle implementation such as for Regulatory or Airspace User driven enhancements.

- **System Expandability**
    - ATMASs have been operated to a 'continuous development' philosophy enabling them to maintain technological and operational effectiveness throughout their lifetimes. For the OCS, the approach produced a system that has been in operation for 25 years while incrementally implementing improved technology and separation standards and managing complex boundary situations with neighbouring FIRs. A similar approach in the Skyline system saw significant development of the system over 20 years and will continue with the roadmap of development for the SkyLine-X.
    - See appendix A for key development items of each system over their lifetimes.

- **Automation of workload**
    - Particularly for OCS, the move from Air Traffic Control to Air Traffic Management has been the most pronounced with the systems-based conflict detection, AIDC coordination, ADS-C/CPDLC functionality and aircraft route/airspace eligibility determination capabilities.
    - The Domestic ATMAS has evolved with several controller support tools – particularly around PBN eligibility, automated SID/STAR assignment and silent coordination of aircraft clearance and movement information. The ATMAS has also been fully integrated into other controller support systems such as AMAN and Electronic Flight Strips (EFS)
    - Automation of each system will only continue- based on guidance such as the GANP and ASBUs. See appendix B for envisaged development items for each system.

- **Component life-cycling**
    - SkyLine and OCS have had several hardware and operating system refreshes through their life cycles (Skyline,1, OCS,3), each with significant in-house design and test efforts preceding implementation.
    - Airways' capability of having expertise in the environment being managed has created a resilience that has reduced the operational impact of lifecycle change. As an example:
        - Airways Domestic ATC core services availability for the last 12 months averages 99.92%. This is above the Target Service Level of 99.87% and includes the transition from old Skyline SkyLine-X Domestic ATMAS.
        - Airways Oceanic ATC core service availability for the last 12 months averages 99.99%. This is also above the Target Service level of 99.93%
    - The ability to conduct system re-hosting in-house has removed the time constraints to ATMAS life cycling that could have otherwise pre-empt significant upgrade or replacement initiatives.

- **Resilience**

    - With the in-house teams' capability, mature lab environments for testing and operational validation, the risk of software/adaptation errors or sub-optimal operational effectiveness entering operational environments is reduced.
    - The iterative development process allows functionality to be built up with confidence and allows builds to be created that are within the capacity of the

[1] Via the presence of interfaces, configuration data, and software switches in both servers and clients (controller and technician workstations)

- teams to test and validate effectively. This reduces risk and improves change management.
- As a result of the capability, test environments and process, Airways has experienced no interruptions of service related to release processes. Errors that do enter the operational world are either mitigated by correction in the next cycle or by immediate patch if deemed too disruptive.
- With the implementation of SkyLine-X, the release process has become almost seamless for Domestic Controllers via the use of channel switching from current to the new release. The functional and process design of this capability is a prime example of partnership-based development.
- Airways has been able to implement effective contingency within its ATMAS. OCS has Main/Reserve/Standby platforms and duplication across geographically remote sites while the domestic system has multi-channel and bypass capability in system, and a 'Two Centres/One system' capability that facilitates continuation of service at either center or via contingency facilities.
- The design and implementation of contingency capabilities reflect the specific needs of the New Zealand environment and the capability within Airways to design and implement solutions for that environment.

Approach Considerations

2.12 The approach taken by Airways represents a significant evolution of its development approach and comes with important considerations, namely:

- **Confirmation of Needs/challenges –** Airways determined an advantage in pursuing a more independent approach, particularly in change management, development, and resilience. Airways assessed the approach optimal to meet the needs of its environment.
- **Accountability -** Airways has developed mature procedures, Quality Assurance and Safety Management processes to ensure safe and efficient delivery of services and works collaboratively with regulatory and assurance agencies to validate the effectiveness of such processes.
- **Cost –** To effect safe and effective independent development and manage development risk required Airways to make significant investment in both human resources, physical infrastructure, and development tools.
- **Timeframe –** Airways followed an evolutionary approach, building its development capability, over a significant period. For an organisation considering Airways approach, this evolution could be accelerated but would depend on the baseline of human and technical capabilities within an organisation and its imperative for change.
- **Opportunity –** With its in-house capability and collaborative/partnership activities recognising that capability, Airways has been able to apply its teams to business opportunities. Prominent examples are:
    - ATOP for the FAA which leveraged off the experience and expertise of the Airways team responsible for the OCS system.
    - Skyline in China (Fuzhou) and Kazakhstan.

2.13 Airways has found its approach advantageous and effective at mitigating the challenges it faced with ATMAS development. The results of the approach have meant that both Domestic and Oceanic systems have been continuously and cost-effectively developed throughout their lifecycles with minimal operational and service disruption resulting.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) Note the information contained in this paper; and

b) Discuss any relevant matter as appropriate.

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Appendix A – Development History for Each ATMAS

Oceanic Control System – 1999 - Today	Skyline – 2003 - 2023
• Significant development of Oceanic Clearance, Coordination and Conflict Probe modules. • RVSM functionality • Major and critical contribution to FAA ATOP bid - 2001.3 hardware and OS upgrades. (2003, 2009 & 2012) • Oceanic Sync Server (Multi-channel capability) • Development of Qt Monitoring and Control client • Moved to fully virtualised platform 2011. • Oceanic HF Air/Ground developed 2012. • FPL2012 • AIDC V2 & V3. • Bespoke VoIP-based HF Tx/Rx system (HFRCS) • Oceanic RNP Separations RNP10, RNP4 (30/30->23/30), RNP2 (D20, 12 lateral). • PBCS in OCS. Development of PBCS and Datalink Problem Reporting Websites. (GOLD) • GRIB pre-COP. • Domestic Runway Data System • Numerous enhancements to datalink (e.g.: BATAP -> MATIP) • ADS-C CDP (Climb/Descent procedures.)	▪ The development of comprehensive bypass modes to increase system resilience against server failure. ▪ The integration of an Airways-developed web-based/airline accessible GDP system ▪ The ICAO 2012 Flight plan ▪ The integration of Frequentis Electronic Flight Strips, DCL and Digital ATIS (which Airways software engineers also maintain and develop). ▪ The integration of a Frequentis-Orthogon arrival manager - AMAN. ▪ Design and implementation of automatic SID/STAR allocation based on aircraft type/airline and PBN eligibility. ▪ Addition of a new server "System Health Processor" type, to provide reporting of system events and anomalies, error, and surveillance and flight data processing details for engineers. ▪ The development of ACDM functionality and interfaces. ▪ RVSM eligibility, CFL monitoring and SUA scheduling functionality. ▪ The integration of Multilateration, ADS-B, and Mode S DAPs. ▪ Fusion tracking of each surveillance type into a single system track including separation eligibility indications ▪ Implementation numerous functional enhancements across the ATMAS (HMI, FDP, SDP, interfaces, system M&C, etc.). ▪ Multiple functions added to enhance the ATMAS simulators used for controller training, such as the ability to pause, slowdown, or speed-up time. ▪ Rehosting of the system from an original proprietary operating system to new hardware on a LINUX operating system with a different endian order; this rehosting performed in a manner that let individual boxes be replaced seamlessly, requiring full interoperability and message exchange between the old and new Operating Systems. ▪ Operating System security patches, configuration changes, and annual upgrades to the latest version to support new hardware. ▪ Fixing a large quantity of functional and stability defects across the system.

Appendix B – Roadmap Items for Each ATMAS

<table>
<tr><td>Oceanic Control System – 1999 - Today</td><td>SkyLine-X 2023 – Today</td></tr>
<tr><td>Near term:
SWIM: FF-ICE, FIXM.
OCS & Air/Ground Virtual Server Hardware and O/S refresh.
HF VOLMET replacement
Upgrades to GRIB Weather model. Architecture changes to efficiently handle increased data capacity requirements.
Redevelopment of Oceanic Sync Server
Medium term:
Replacement of Middleware with more modern version. (E.g.: Implementation of OMG DDS specification)
Port of OCS/AG to x86 Operating System. (Linux or BSD).
Deconstructing OCS modules from monolithic applications to individual services.
Move from Processor driven Architecture to Data Driven Architecture. (Better geographic spread, better resilience).
New HMI.</td><td>Near term:
Domestic – CPDLC
Stripless surveillance services operation
Enhanced Collaborative Flow Manager capability
EFS-X deployment to more towers
SWIM, FF-ICE, IXM's
Further trajectory capability
MTCD enlivenment
Graphical Route Editor (GRE)
Medium Term:
RECAT support tools for arrival management
Departure Management (via ACDM)
Enhanced conformance monitoring
UTM integration elements
TBO elements</td></tr>
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