International Civil Aviation Organization

EIGHTEENTH MEETING OF THE COMMUNICATIONS/NAVIGATION AND SURVEILLANCE SUG-GROUP (CNS SG/18) OF APANPIRG

Asia and Pacific Regional Sub-Office, Beijing, China
(21 – 25 July 2014)

Agenda Item 7.2: **Discuss surveillance related issues**

SOUTHERN SURVEILLANCE

MLAT/ADS-B IMPLEMENTATION IN NEW ZEALAND

(Presented by Airways Corporation New Zealand)

SUMMARY

This paper presents Information of the implementation of MLAT/ADS-B within the NZ (Domestic) FIR.

1. INTRODUCTION

1.1   On 4TH Dec 2013 Airways Corporation's MLAT system located in THE Queenstown area went live providing MLAT and ADS-B data to the Airways Skyline ATM system. The system provides coverage over the lower half of the South Island of New Zealand which was previously only partially covered by 1 Mode S SSR located in the hills above Christchurch.

1.2   The system has been operational for 8 months, with the data from the system being FUSED within the SKYLINE Surveillance Data Processor (SDP).

1.3   The MLAT system is designed to operate to an N-2 standard.

2. DISCUSSION

2.1   As part of the fused system track the Airways ATM system provides the controller with a position symbol indicating the separation standard applicable, rather than the surveillance type(s) making up the system track.

2.1.1   3NM separation is indicated by a triangle position symbol;

2.1.2   5NM separation is indicated by a polygon position symbol; and

2.1.3   Primary only tracks remain a circle.

2.2   Airways are planning to extend the domestic airspace boundary to the west of Queenstown to the extent of ADS-B coverage, to provide an enhanced service to arriving and departing Trans-Tasman flights – proposed implementation date (17 September 2014).

2.3   The New Zealand Government through the CAA has just released the National Airspace and Air Navigation Plan "New Southern Sky". One of the most significant aspects of the Plan is to move from land-based systems to space-based satellite navigation and surveillance. Key points of the plan are:

- ADS-B mandatory airspace above FL245 by 2018; and

- ADS-B mandatory in all controlled airspace by 2021 with a contingency surveillance network in place (e.g. MLAT over major TMAs)

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 matters as appropriate.

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Airways New Zealand

Southern Surveillance
Multilateration and ADS-B Implementation

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Introduction of MLAT and ADS-B into ATM System

- **QN Multilateration System**:
  - Operational in 2009
  - Initially used only by QNTWR for situational awareness
  - Restricted to MLAT data only due to display limitations
  - Helped to enable:
    - PBN implementation
    - 0.3 RNAV approaches
   - Increase in Jet traffic

- **Integration into Skyline ATM System:**
  - ➢ Software changes and testing began in 2009. Included
    - Converting radar Aircat 500 data from Mode S Radars to CAT48 and processing data with ATM
    - Converting internal ATM messaging from CAT30 to CAT62
    - Introducing CAT19/20/21/23
    - Review and update of Safety Net Processing
    - Fusing Sensor Surveillance data to provide one system track (PSR, SSR, MLAT, ADS-B)
    - Changing displayed Surveillance position symbols to show the applicable Surveillance Separation Standard instead of the previously accepted display of sensor(s) making up the system track.
    - Including integration of ADS-B/Mlat into Emergency Bypass and Single-Sensor processing modes
    - Adding correlation by Flight-ID and Mode-S Address
    - Adding a sophisticated automated data analysis facility, daily reporting surveillance correctness against EUROCONTROL 's 2012 Specification for end-to-end Surveillance System Performance "EUROCONTROL-SPEC-0147"
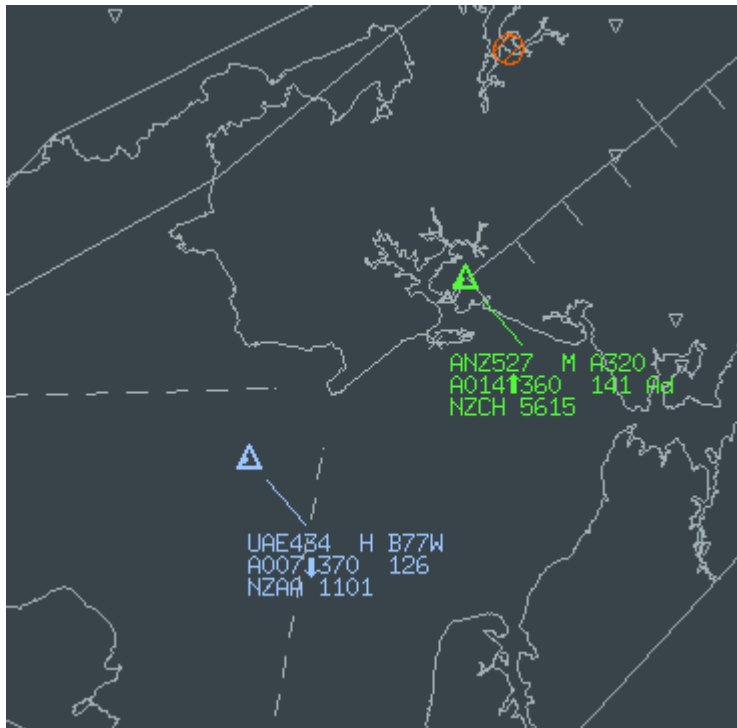   - Adding other tools, such as the "Popcorn" sensor comparison mode

- **QN Multilateration - Southern Surveillance expansion:**
  - ➢ Operational Dec 2013

Multilateration/ADS-B Integration into SkyLine Surveillance Data Processors
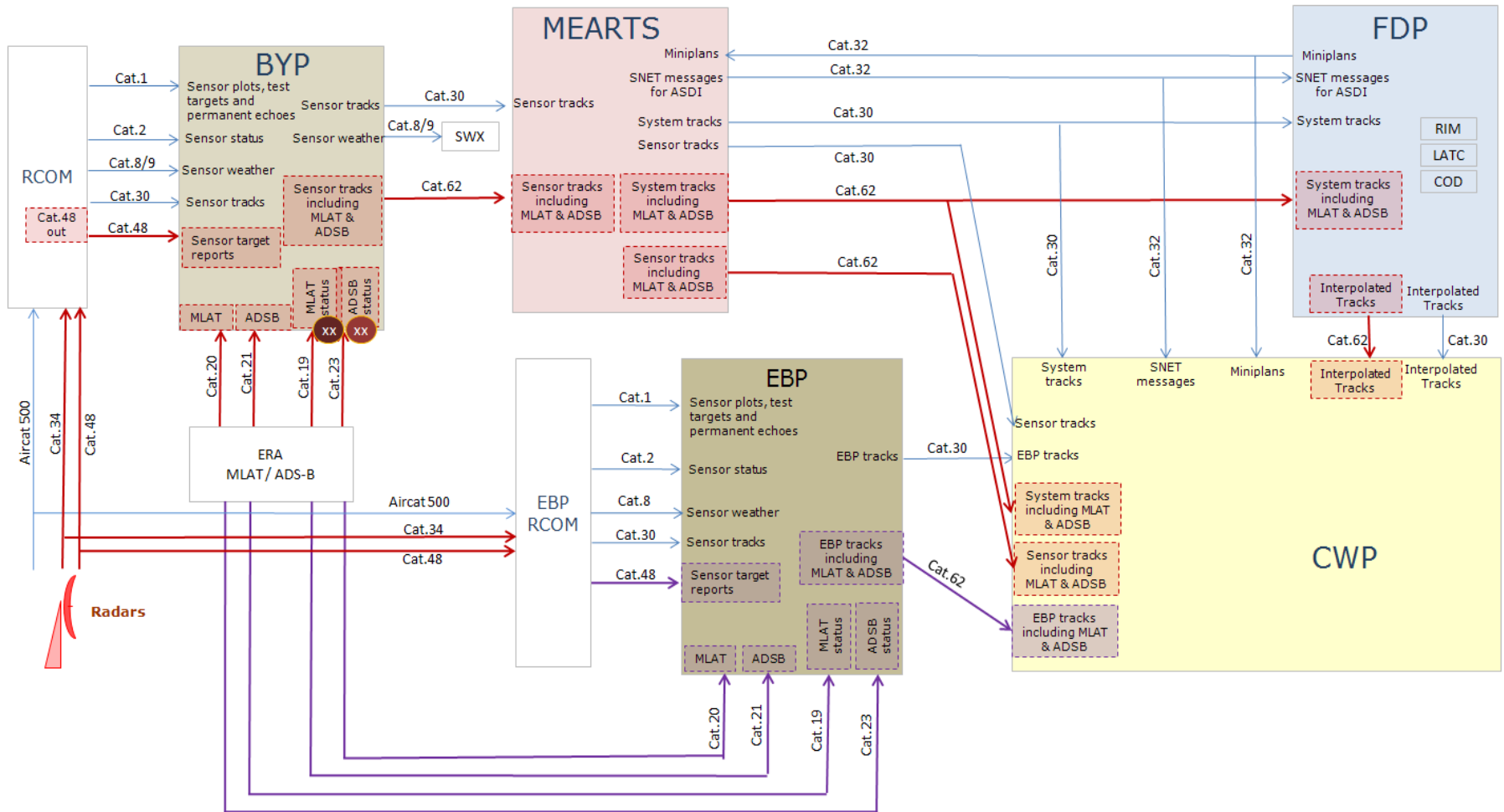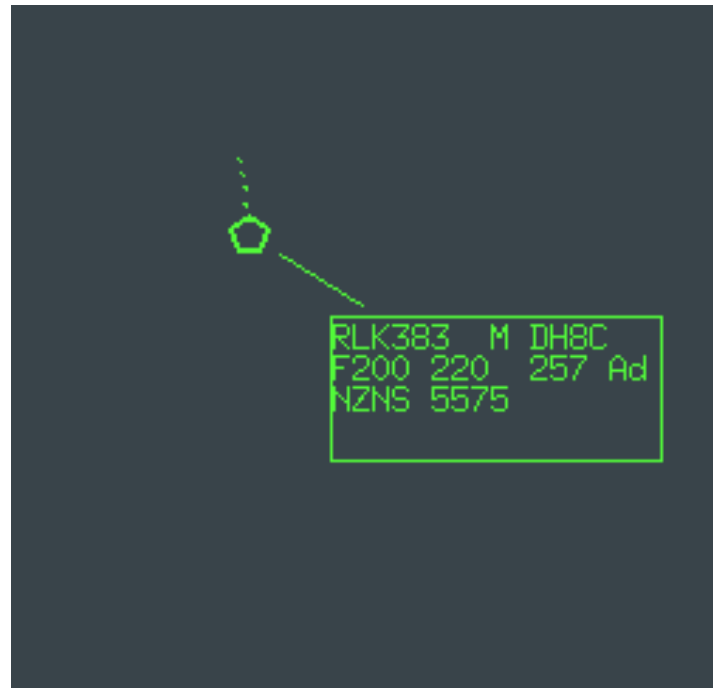
3 NM Separation Symbol

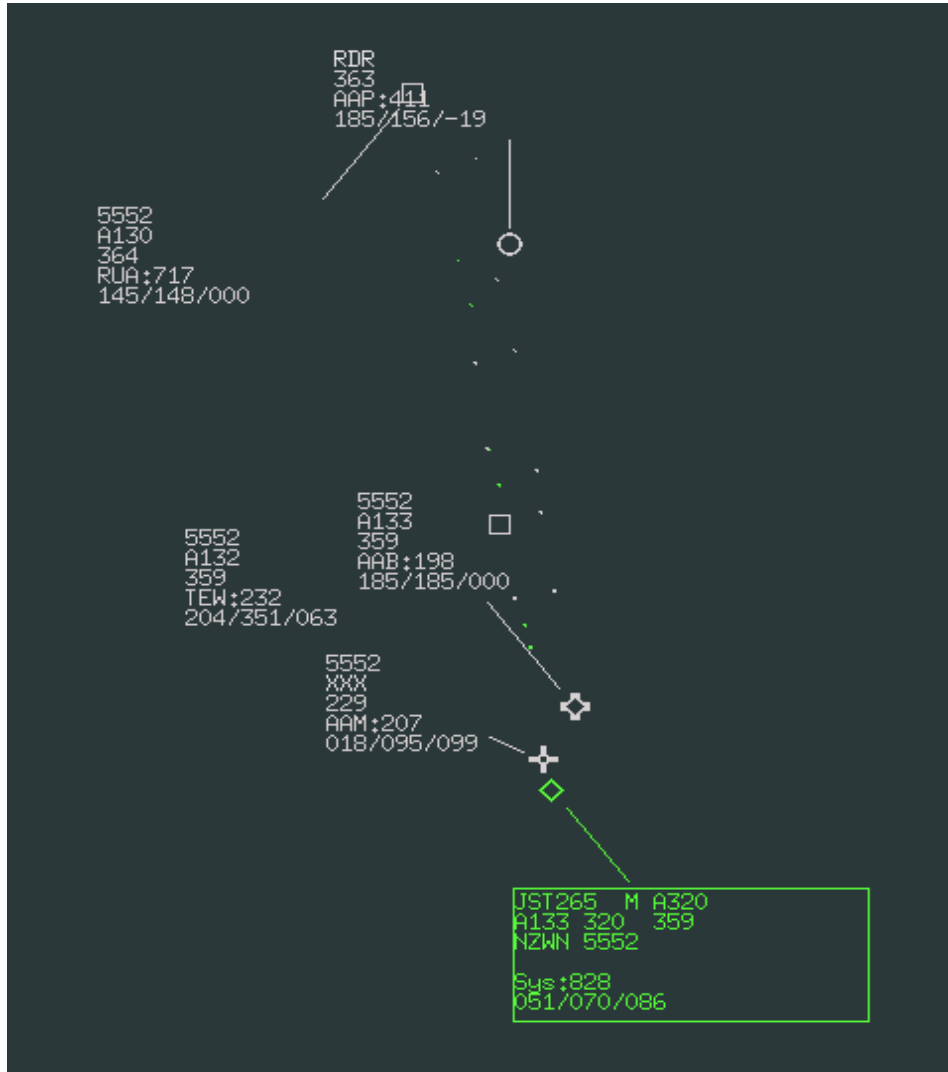3NM separation requires all of these conditions to be met:

- Terminal sector
- Aircraft < 400kts
- Aircraft has Mode-C
- Aircraft is within 60 nm of designated sensor
- CWP in fusion mode (not bypass)
- CWP range <= 70nm on fully-expanded window on a 2Kx2K display

3nm can be switched off by the controller.

5 NM Separation Symbol

Popcorn (Sensor comparison mode)

Engineering tool shows all constituent targets contributing to the fused track:
- For a selected track
- Label bottom line shows stdDevs
- Will follow that track

Example:
Jetstar265 southbound from Auckland, seen by:
- AAP – Primary radar
- RUA - Mode-S SSR
- TEW – Mode-S SSR
- AAB - ADS-B
- AAM - Multilat

The fused track is in green.

Validation Objectives

Defined by the EUROCONTROL-SPEC-0147.

Broadly:

- Positional accuracy
- Velocity
- Mode 3A, Mode S, Mode C
- Probability of detection taking into account ATM filtering of surveillance source data
- ATM Surveillance availability
- Latency will be measured, but is already a component of positional accuracy.
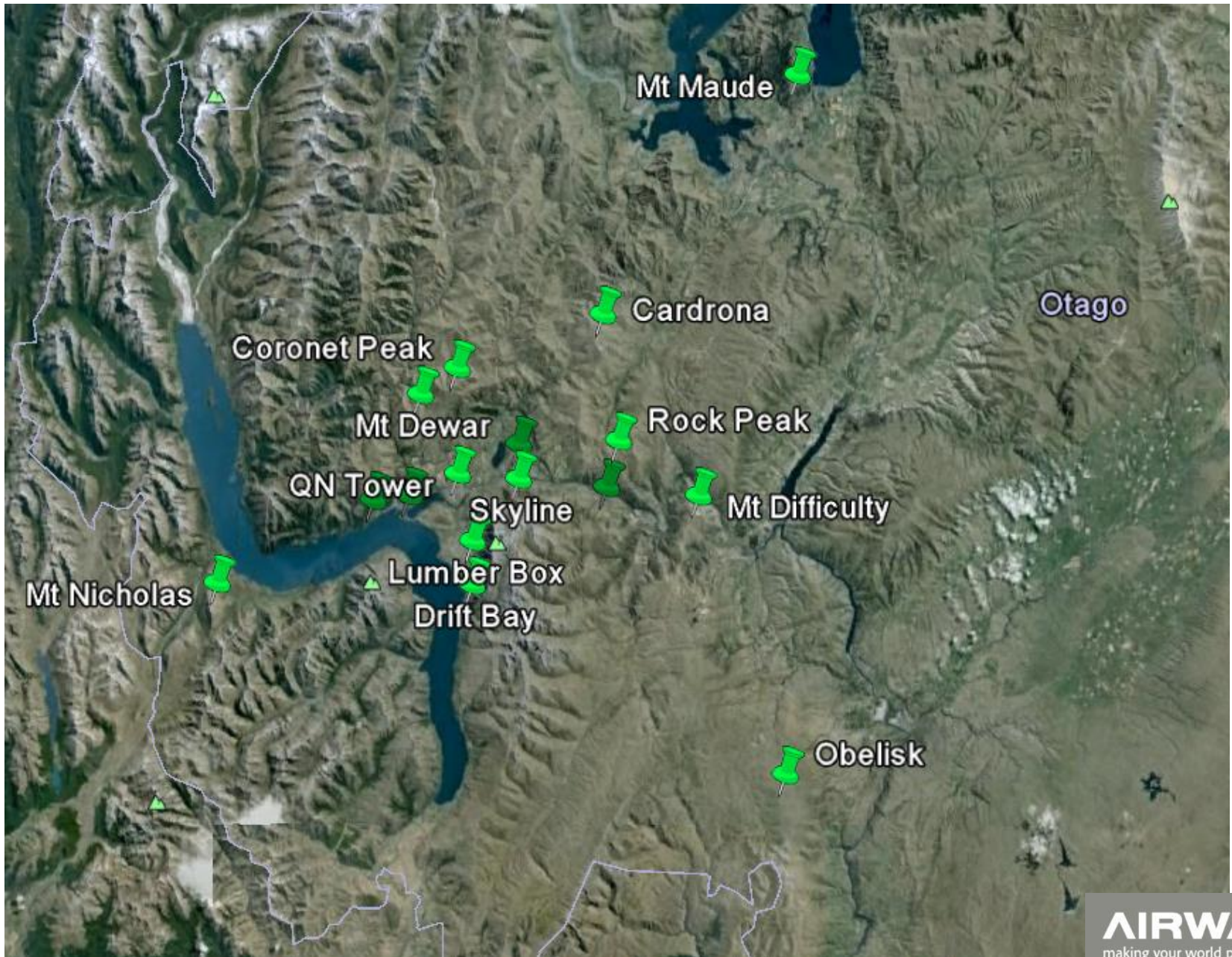- Error mean, maximum, and standard deviation.

Southern Surveillance

Current v Delivered

QN MLAT SYSTEM

➢ Status of MLAT Sites pre Southern Expansion

Cardrona

Coronet Peak

Mt Dewar

Rock Peak

Morven Hill

QN Tower

Gibbston

Sunshine Bay

Skyline

Mt Difficulty

Lumber Box

Mt Nicholas

Drift Bay

Obelisk

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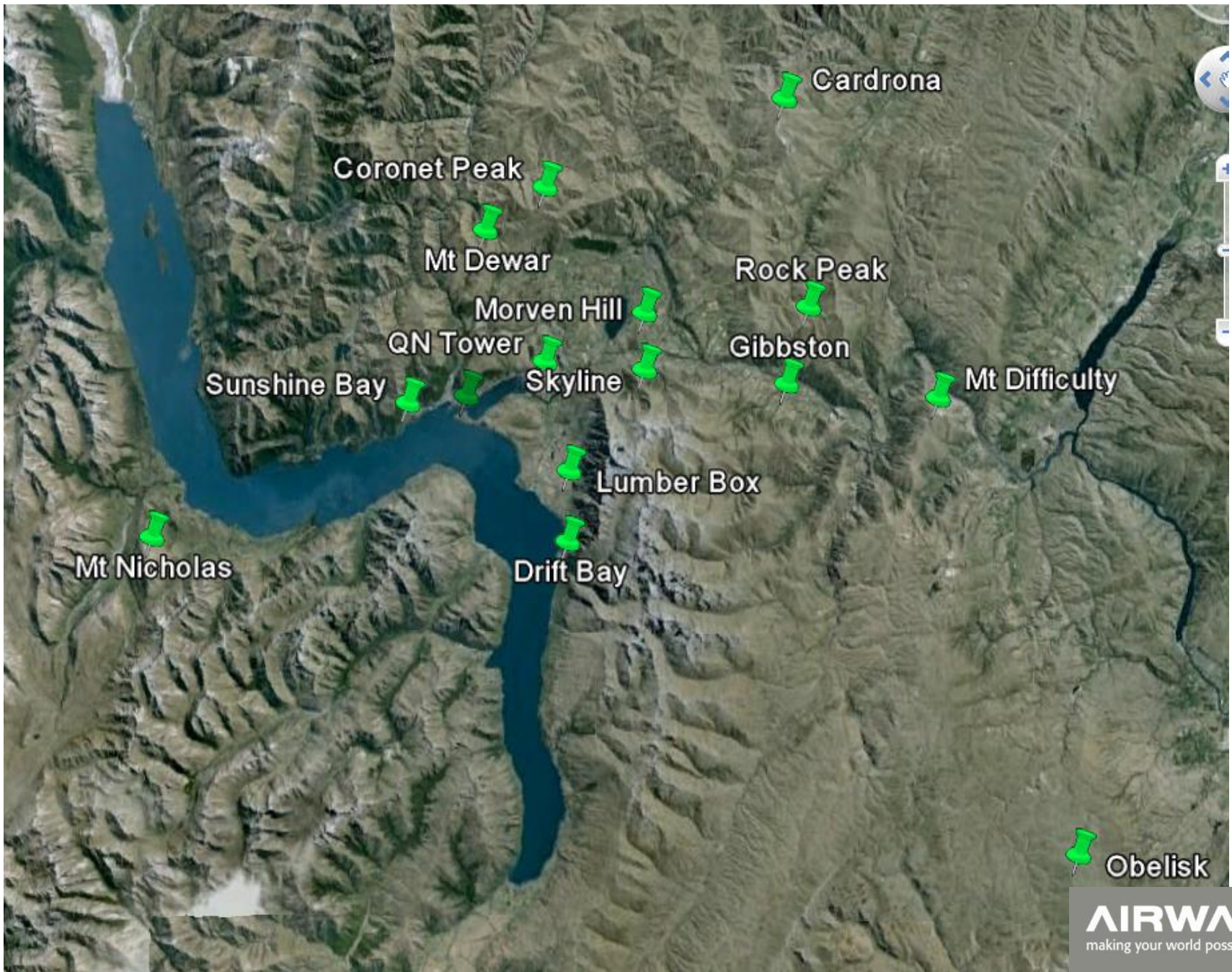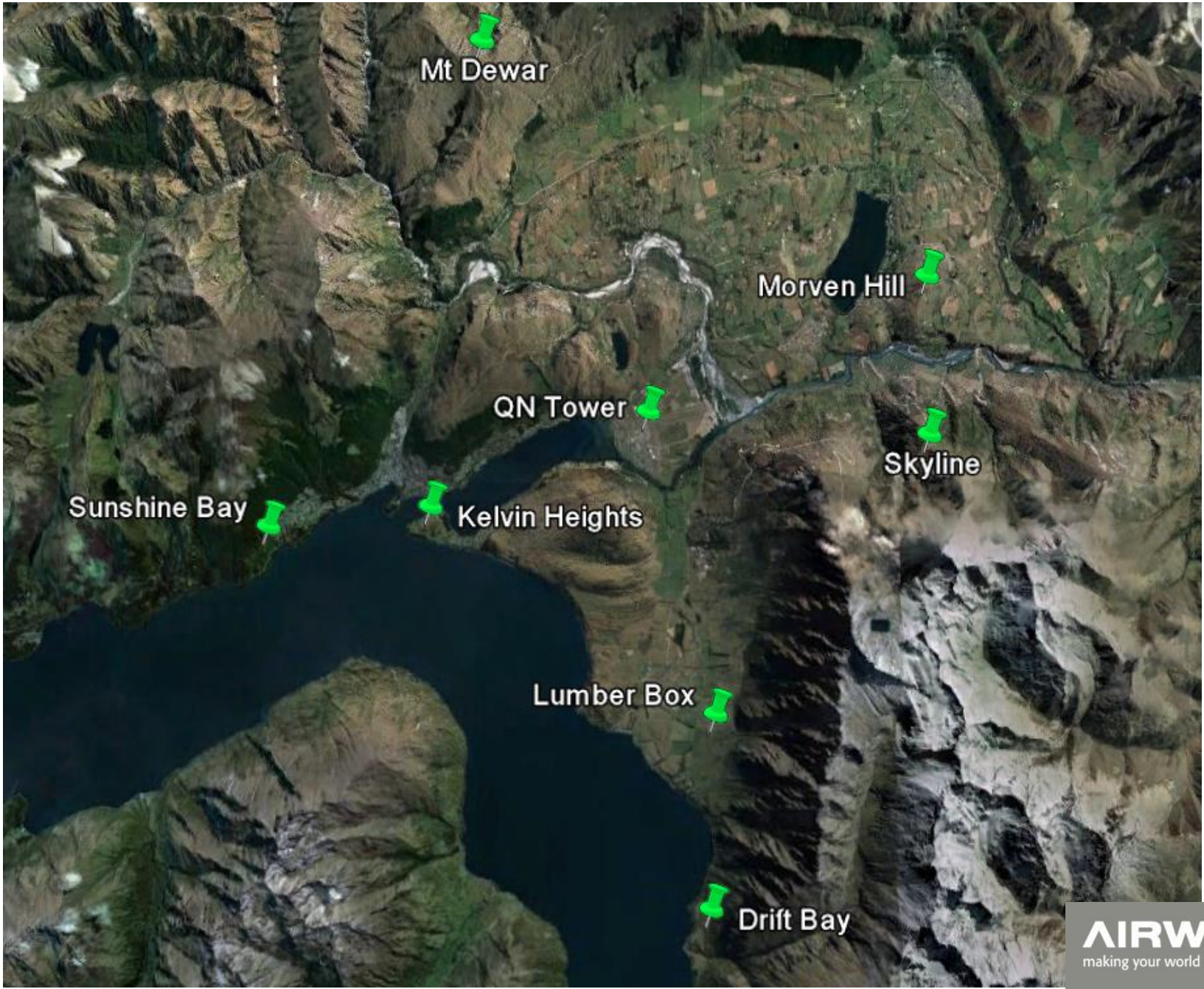
Mt Dewar

Morven Hill

QN Tower

Skyline

Sunshine Bay

Kelvin Heights

Lumber Box

Drift Bay

ATM Surveillance Coverage Prior to Southern Surveillance
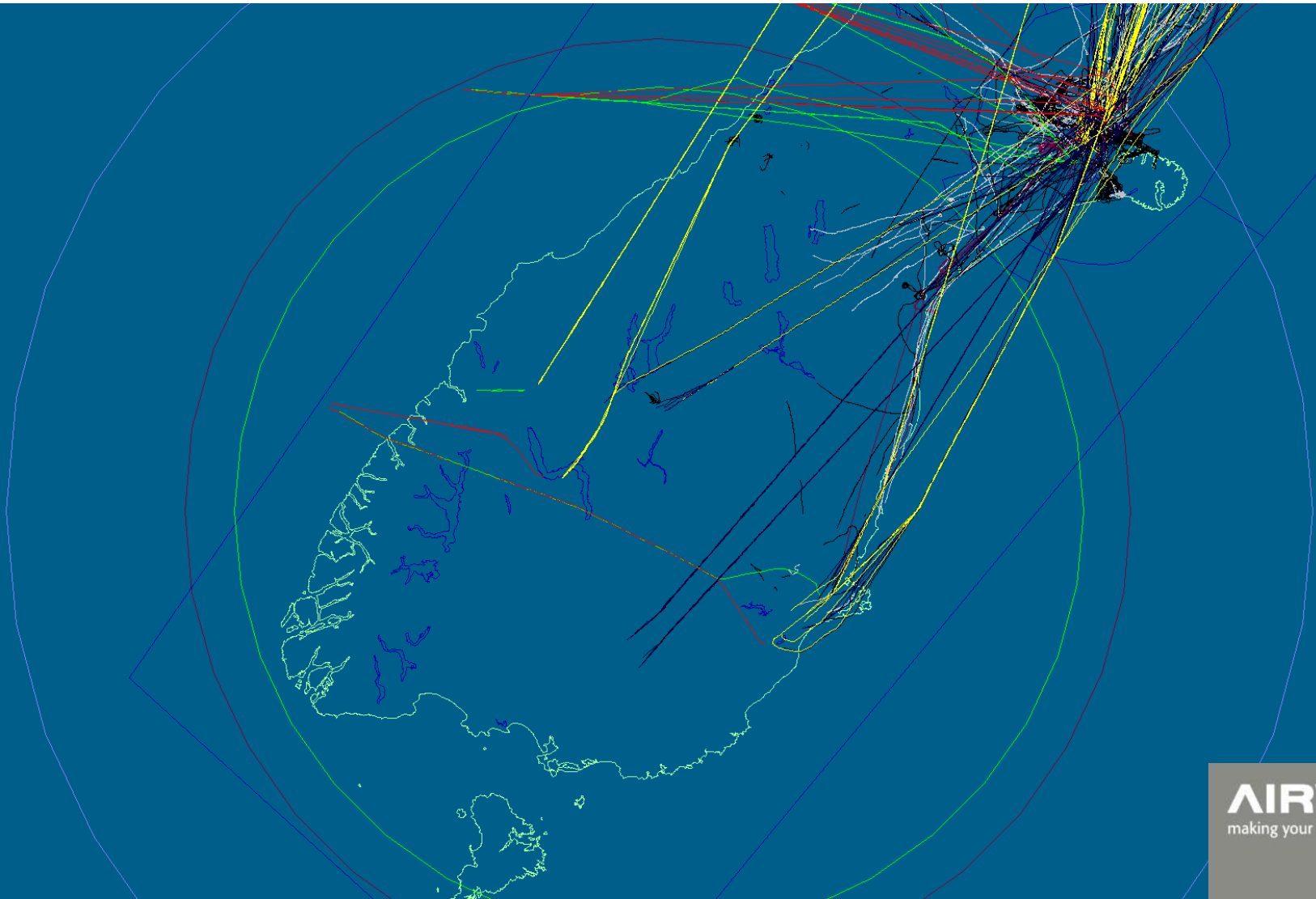
QN MLAT SYSTEM

➢Status of MLAT Sites after Southern Expansion

MLAT Southern Expansion

New Sites:
Mt Prospect
Bald Hill
Kuriwao
Mt Stuart
Mt Cargill
Mt Studholme
Mt Mary
New Ref Transponders:
High Peak
Wether Range

Existing Sites:
Mt Dewar
Mt Nicholas
Mt Difficulty
Obelisk
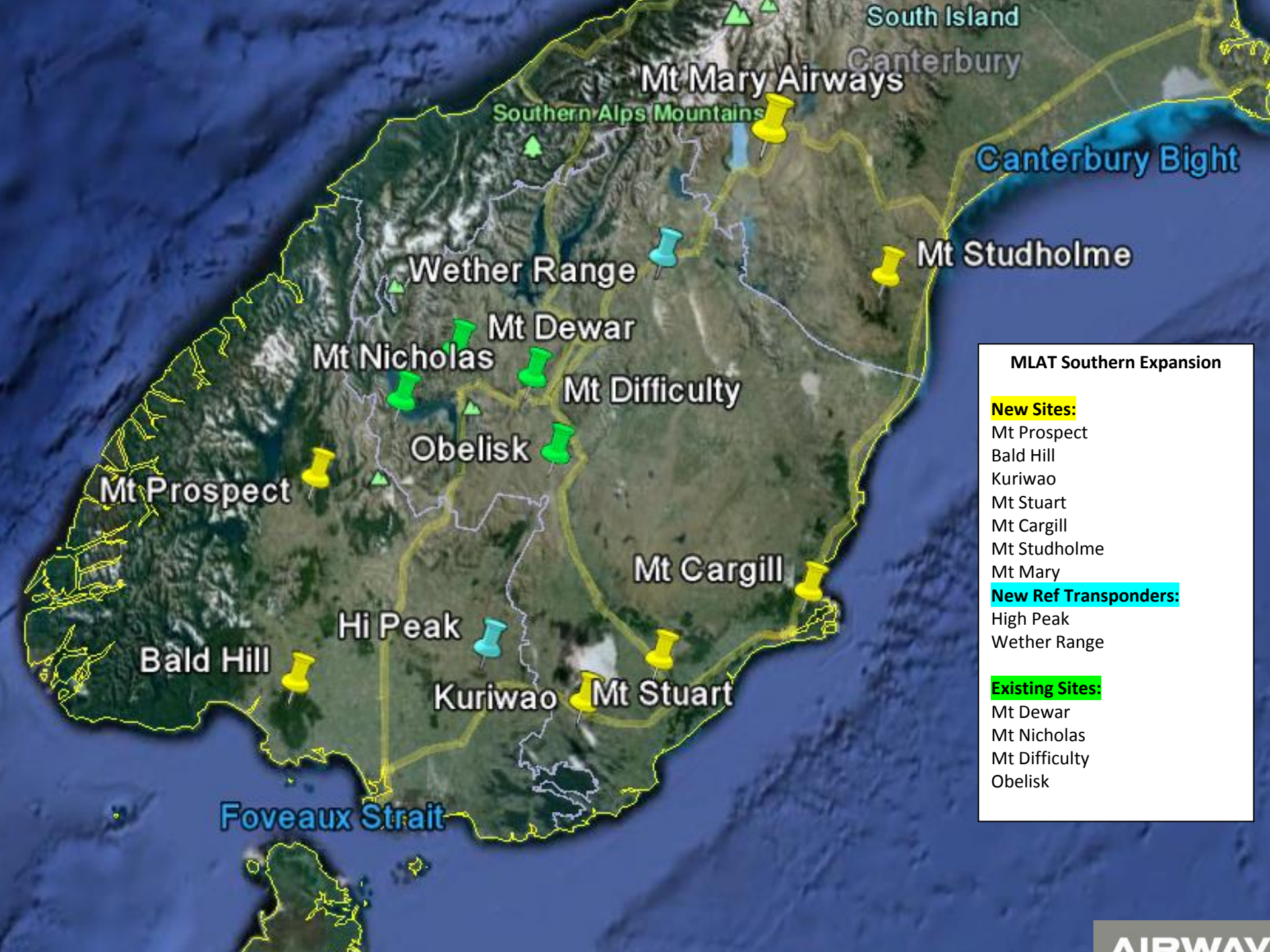
ATM Surveillance Coverage
Post Southern Surveillance
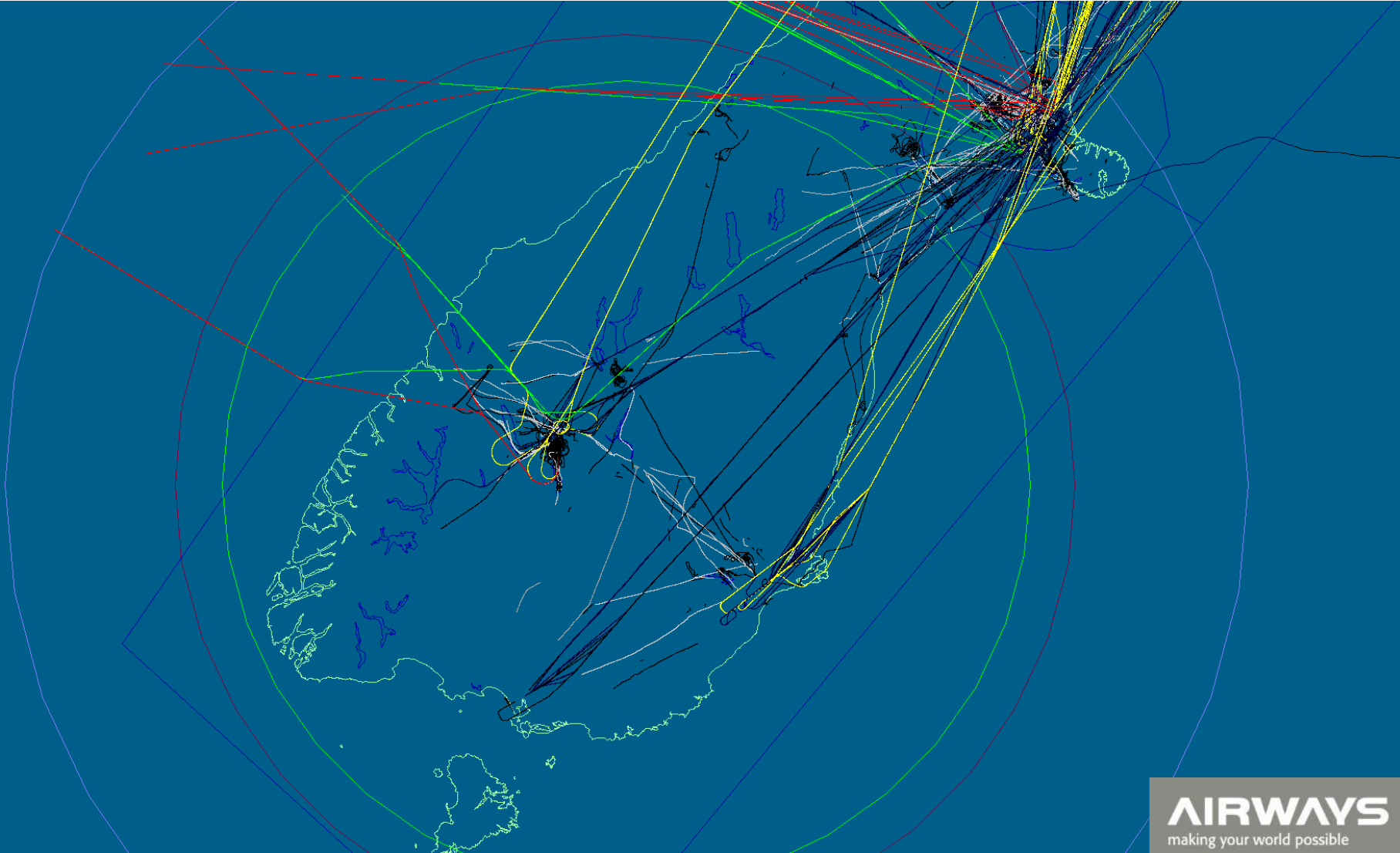
Outline of Southern Extension Work

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Outline of Southern Surveillance Extension work

Surveillance Engineering

➤ Southern MLAT expansion included:

- Design philosophy - Use of ATDI as an agreed validation tool for modelling new sites, and to predict the resulting coverage area.
- Reliability including; dual path communications to QN, loss of power to one site covered by n-1, n-2 conditions. Modelling shows 99.997% for n-2.
- Ref-trans chosen to have visibility of four Receiver/Transmitter sites each
- Additional site added (Mt Stuart) for additional site redundancy

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Site Acceptance

- ➢ Site Acceptance of the new sites – Calibration flight test and ADS-B targets of opportunity.
- ➢ Confirmation that Southern Expansion is covered by the existing Part 171 Safety case and that this is just an expansion of the already approved system.

Site Acceptance Testing

SAT PROGRAMME

Calibration aircraft

➢ PA44T (3 crew - 2 pilots, 1 engineer)

Time

➢ 15-20 hours over a 5 day period

Test Programme

➢ Fly 9 test flights around predicted coverage areas established by ATDI tool to meet coverage over controlled airspace. The lower airspace required separate flights for MODE A/C and MODE S.

➢ Use data from targets of opportunity (e.g. ADS-B equipped flights certified to meet the Australian ADS-B standard flying Trans-Tasman.

SAT Test Flights

Calibration Aircraft

➢ As programmed SAT Test Flights

Time

➢ 29.46 hours over 9 days.
➢ Programme started 1 day late due to aircraft availability, additional flying required, crew rest day required.
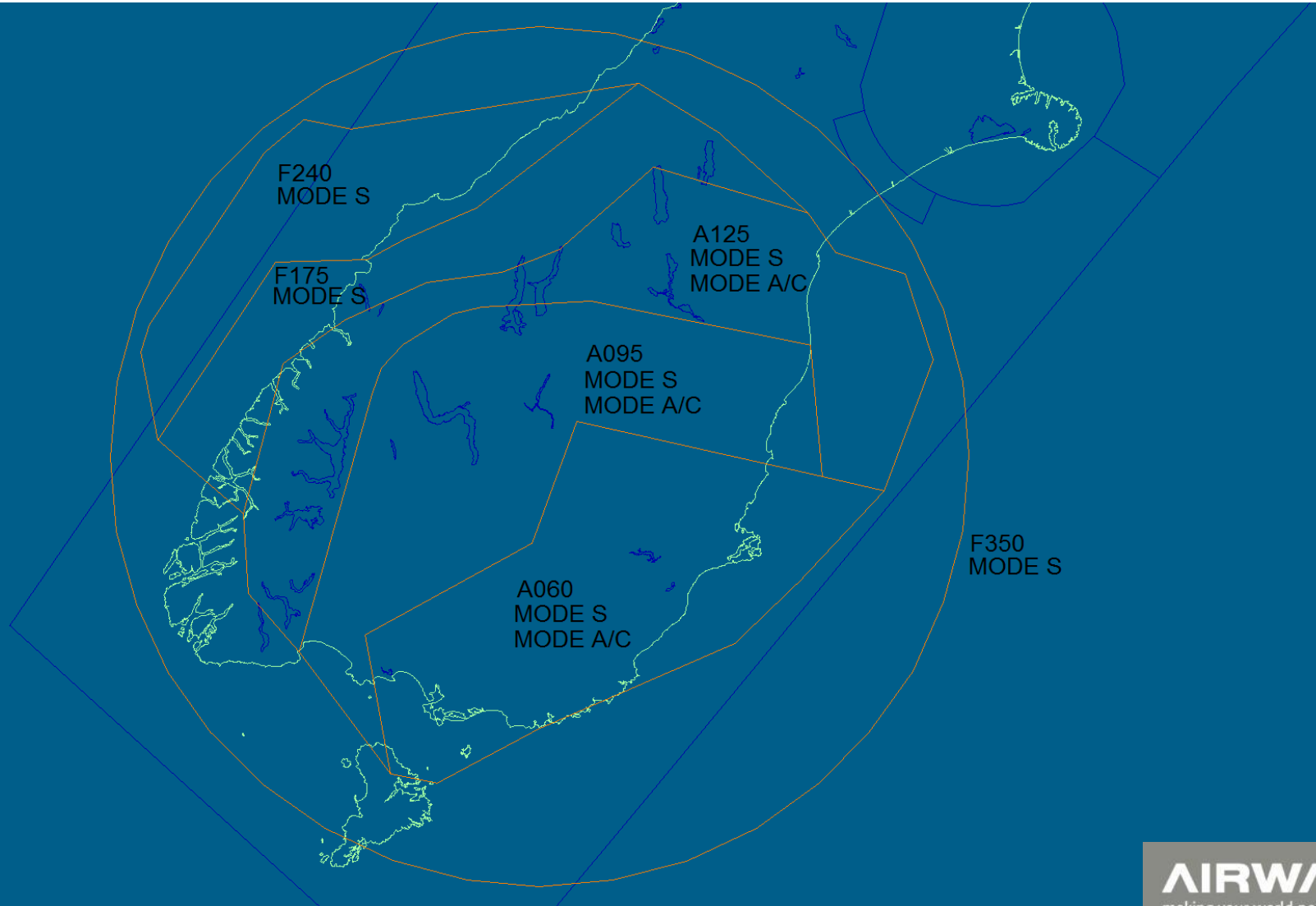
Test Programme

- ➤ Flew 13 test flights.
  - 7 additional flights were required
    - ▪ 4 reruns
    - ▪ 3 additional tests to capture data from areas where issues where identified.
- ➤ Targets of opportunity using appropriately certified ADS-B aircraft.

Test Flight Polygons/Altitudes

MLAT and ADS-B Coverage

ADS-B Coverage
200NM FL200+

ADS-B Coverage
145M

MLAT
Coverage
130NM

Technical Verification

Review the complete MLAT system for compliance in particular with Appendix C & D of "ICAO CIR326"

- ICAO Cir326 SASP (Separation and Airspace Safety Panel) compares radar and MLAT / ADS-B for separation suitability.

- The Panel concludes that MLAT and ADS-B surveillance is better (or at least no worse) than the reference SSR, and therefore no less safe than radar.

- ICAO Cir326 provides a basis for an Airways surveillance performance comparison of SSR radar (Cass Peak) and MLAT and ADS-B (ZQN).

TC training, system monitoring

Network

Safety Case

- Review of current Part171 safety case and update accordingly

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Operational Verification

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CAR Part 172 Safety Case

Develop Safety Case to demonstrate that the integration of MLAT data into Skyline meets an acceptable safety level.

- ➤ Risk Identification
- ➤ Risk Evaluation
    - ▪ Likelihood of occurrence
    - ▪ Severity of consequence if hazard occurs
    - ▪ Mitigation

ATM Software Verification

ATM Software Verification

Standards

- EUROCONTROL Specification for ATM Surveillance System Performance 30/03/2012 EUROCONTROL-SPEC-0147

- ICAO Assessment of ADS-B and Multilateration Surveillance to Support Air Traffic Services and Guidelines for Implementation 2012 Cir 326 AN/188

Reference Tracks

- Initial Reference tracks: Calibration flight (ADS-B)

- Second stage Reference Tracks: ADS-B/TOO (Targets Of Opportunity) filtered to remove suspect aircraft, and to remove obvious aircraft errors *(e.g. older A320 backward jumps)*

Validate against Reference Tracks

- Radars as received by the ATM
- MLAT as received by the ATM
- Fused radars
- Fused radars plus MLAT
- Fused radars plus ADS-B
- Fused MLAT plus ADS-B
- Fused radars plus MLAT plus ADS-B

Notes

- 50,000 sample minimum required for definitive analysis
- Calibration flights are limited.
- Fused MLAT + Radar flights are limited
- Fused MLAT + Radar + ADS-B flights are limited

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Validation Objectives

Defined by the EUROCONTROL-SPEC-0147.

Broadly:

- Positional accuracy
- Velocity
- Mode 3A, Mode S, Mode C
- Probability of detection taking into account ATM filtering of surveillance source data
- ATM Surveillance availability
- Latency will be measured, but is already a component of positional accuracy.
- Error mean, maximum, and standard deviation.

Contents:

(top of the) System Health Processors' "Surveillance Data Processing" report, automatically generated daily and emailed to engineering.
Anomalies against EUROCONTROL mandatory requirements are high-lighted in yellow.

Report start: Sun Jul 6 18:18:02 GMT 2014

Track Analysis Report

Sensor	Reports	Positional Accuracy				Straight Velocity Accuracy		In Turn Velocity Accuracy		Sensor accuracy	
		Mean(m)	StdDev(m)	RMS(m)	Bad Pos	Speed(m/s)	Heading(degs)	Speed(m/s)	Heading(degs)	Range(m)	Azimuth(degs)
				5N_C-R4	5N_C-R5	5N_C-R17	5N_C-R18	5N_C-R17	5N_C-R18		
				(M) <500m	(R)<0.03%	(R) <4m/s	(R) <10degs	(R) <8m/s	(R) <25degs		
SYS	659468	29.64	31.96	43.59	0.001%	2.41	1.83	4.14	10.47	0.00	0.000
AAB	533224	24.46	20.61	31.99	0.000%	1.33	0.25	2.39	1.68	0.30	0.001
AAM	611	35.25	31.04	46.97	0.000%	2.78	0.47	3.00	16.24	5.91	-0.311
BAL	30095	207.63	172.52	269.95	0.000%	5.09	1.71	12.11	21.94	44.40	0.006
CAS	16586	355.76	213.43	414.87	0.314%	4.32	1.20	11.08	11.23	70.09	0.073
HHR	30920	223.98	147.06	267.95	0.023%	4.30	1.11	7.18	6.13	93.01	0.003
MRB	32523	172.63	102.50	200.76	0.000%	4.25	1.15	6.84	7.60	61.07	-0.013
QNB	142889	24.40	21.55	32.56	0.000%	1.20	0.48	2.37	1.03	0.33	0.000
QNM	77548	54.07	66.99	86.08	0.000%	1.47	1.49	1.80	4.95	-0.99	0.003
RUA	104491	175.50	153.13	232.91	0.020%	2.88	1.37	4.69	8.31	58.53	-0.030
TEW	92670	338.25	208.89	397.56	0.190%	4.26	1.59	9.13	13.38	108.42	-0.076

Altitude/Identity Analysis Report

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IN SUMMARY

- MLAT/ADS-B LIVE IN SKYLINE ATMS SINCE 4 DEC 2013
- FUSED SYSTEM TRACK DISPLAYING SEPARATION STANDARDS NOT SURVEILLANCE TYPE(S)
- ATDI TOOL USED TO PREDICT COVERAGE OF NEW SITES
- EXTENSIVE FLIGHT TESTING AND USE OF TARGETS OF OPPORTUNITY TO PROVIDE VERIFICATION OF BOTH MLAT/ADS-B SYSTEM PERFORMANCE AND ATDI TOOL PREDICTION COVERAGE
- FINAL SYSTEM ACCURACY IS PROVEN FROM SURVEILLANCE SYSTEM TO ATM SYSTEM
- SYSTEM ACCEPTED BY CONTROL STAFF WHO IMMEDIATELY WANTED THE BENEFITS EXTENDED.

- POSITIVE CHANGE RESULTING FROM THE INTRODUCTION:
  - EXTENDING AIRSPACE TO WEST OF QUEENSTOWN IN SEPTERMBER 2014 TO PROVIDE BENEFITS TO TRANS-TASMAN TRAFFIC

THANK YOU