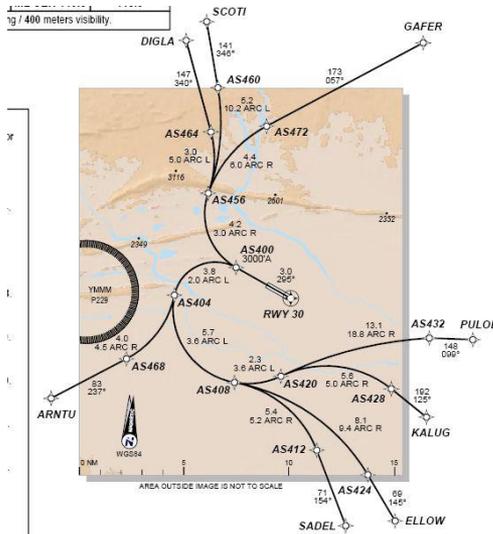


GPS & Australian Aviation

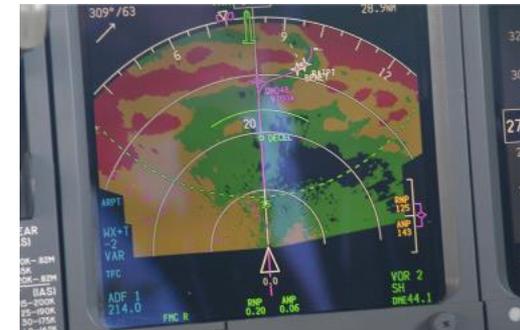


CGSIC

International Information Session

Nashville, Tennessee

16 September 2013



Ed Williams

Navigation Planning

Airservices Australia

connecting australian aviation

-
- Australian Aviation Context
 - GPS and Aircraft Navigation
 - GPS and Aircraft Surveillance
 - Fitment Mandates in Australia
 - Thanks and Thoughts

2005 - 2025 Cumulated Growth

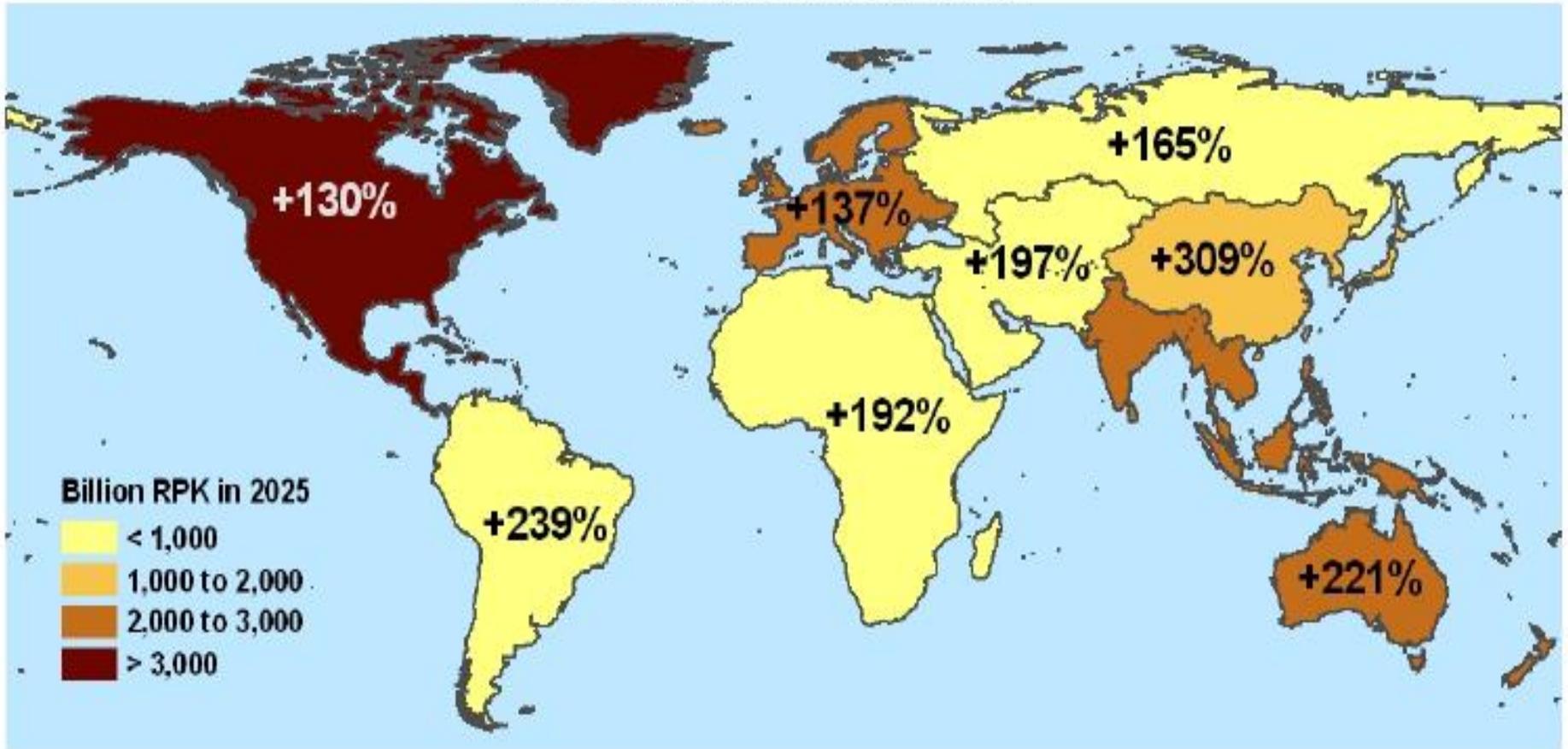
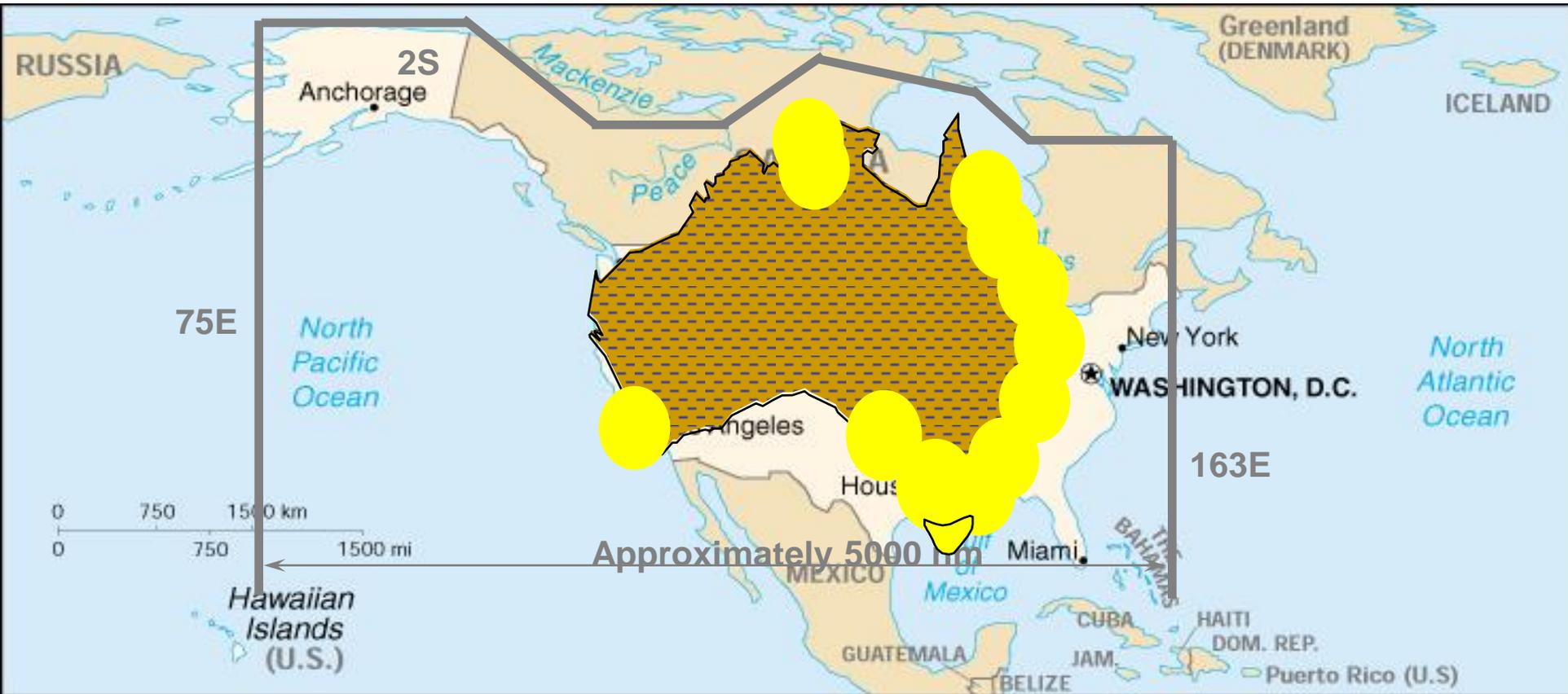


Fig.2-5 : Long-term Forecasts in Worldwide Traffic Growth

Australia's ATC Environment



 Radar Separation

 Procedural Separation + ADS-B

-
- Australian Aviation Context
 - **GPS and Aircraft Navigation**
 - GPS and Aircraft Surveillance
 - Fitment Mandates in Australia
 - Thanks and Thoughts

User Preferred Route

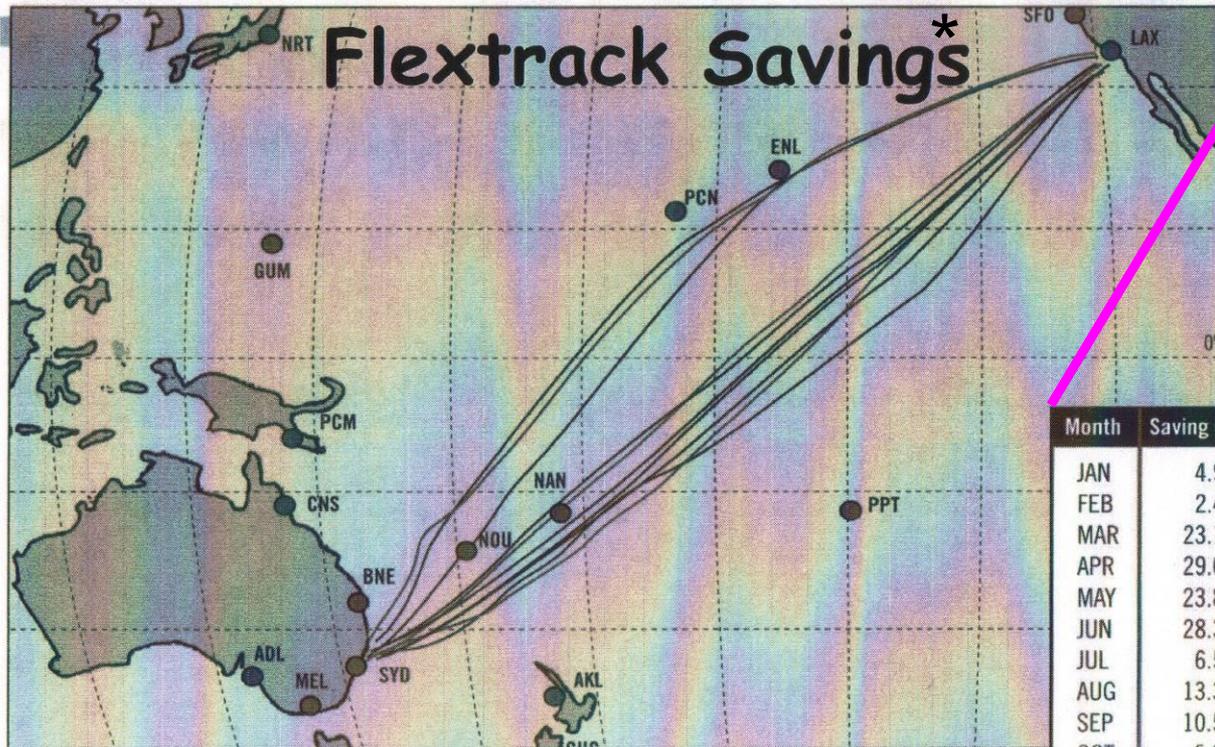


Figure 2. Los Angeles-Sydney daily flexible track plot for one week (with optimum daily routes in black and optimum fixed-track routes in red). Box indicates time saving achieved for different months of the year.

Month	Saving (min)
JAN	4.9
FEB	2.4
MAR	23.1
APR	29.0
MAY	23.8
JUN	28.3
JUL	6.5
AUG	13.3
SEP	10.5
OCT	5.3
NOV	2.5
DEC	6.3

Month	Saving (min)
JAN	4.9
FEB	2.4
MAR	23.1
APR	29.0
MAY	23.8
JUN	28.3
JUL	6.5
AUG	13.3
SEP	10.5
OCT	5.3
NOV	2.5
DEC	6.3

$$2.4 < 29 \text{ mins} * 8 \text{ flights} = 0.3 < 3.8 \text{ ft hours/day}$$

$$0.3 < 3.8 \text{ hr} @ 11 \text{ tonne/hr} = 3.3 < 41.8 \text{ tonne/day}$$

$$3.3 < 41.8\text{t} * 10.8 * 59 * 1.48 = \$ 3,112 < 39,420 \text{ AUD}$$

$$3.3 < 41.8\text{t} * 3.3 = 10.9 < 138 \text{ tonne CO}_2$$

User Preferred Route ...



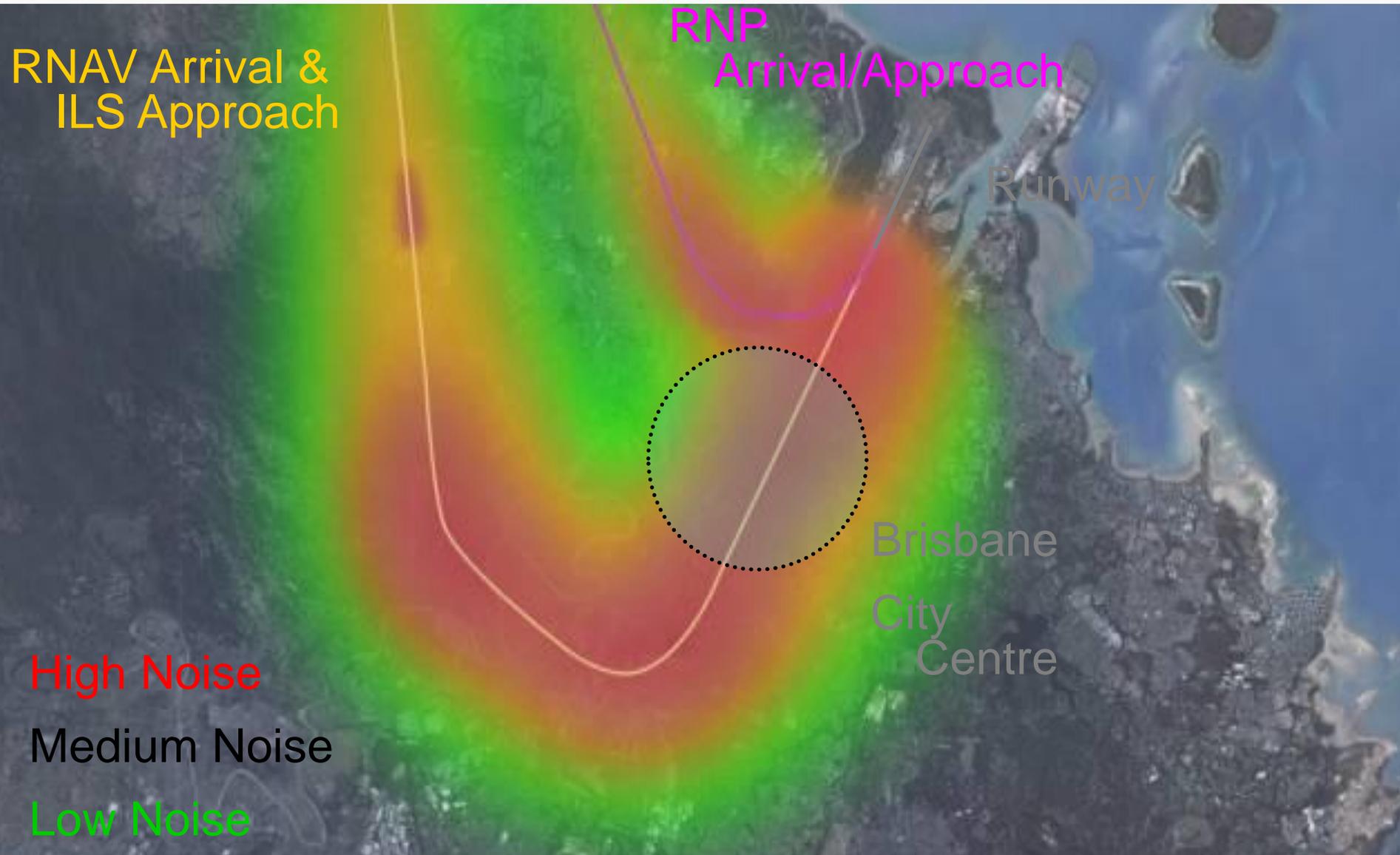
- Pioneered in 2000 across the Pacific Ocean by:
 - Qantas
 - United Airlines
 - Air New Zealand

- Available for routine daily service across Pacific and Indian Oceans
- Used routinely by:
 - Qantas, United Airlines, Air New Zealand
 - Pacific Blue, Air Canada, LAN Chile, Emirates

- Aircraft types
 - Boeing - B787, B777, B747
 - Airbus – A380, A340, A330

- Being trialled domestically on Perth – Cairns (B737-800 / A330)

PBN at Work



High Noise

Medium Noise

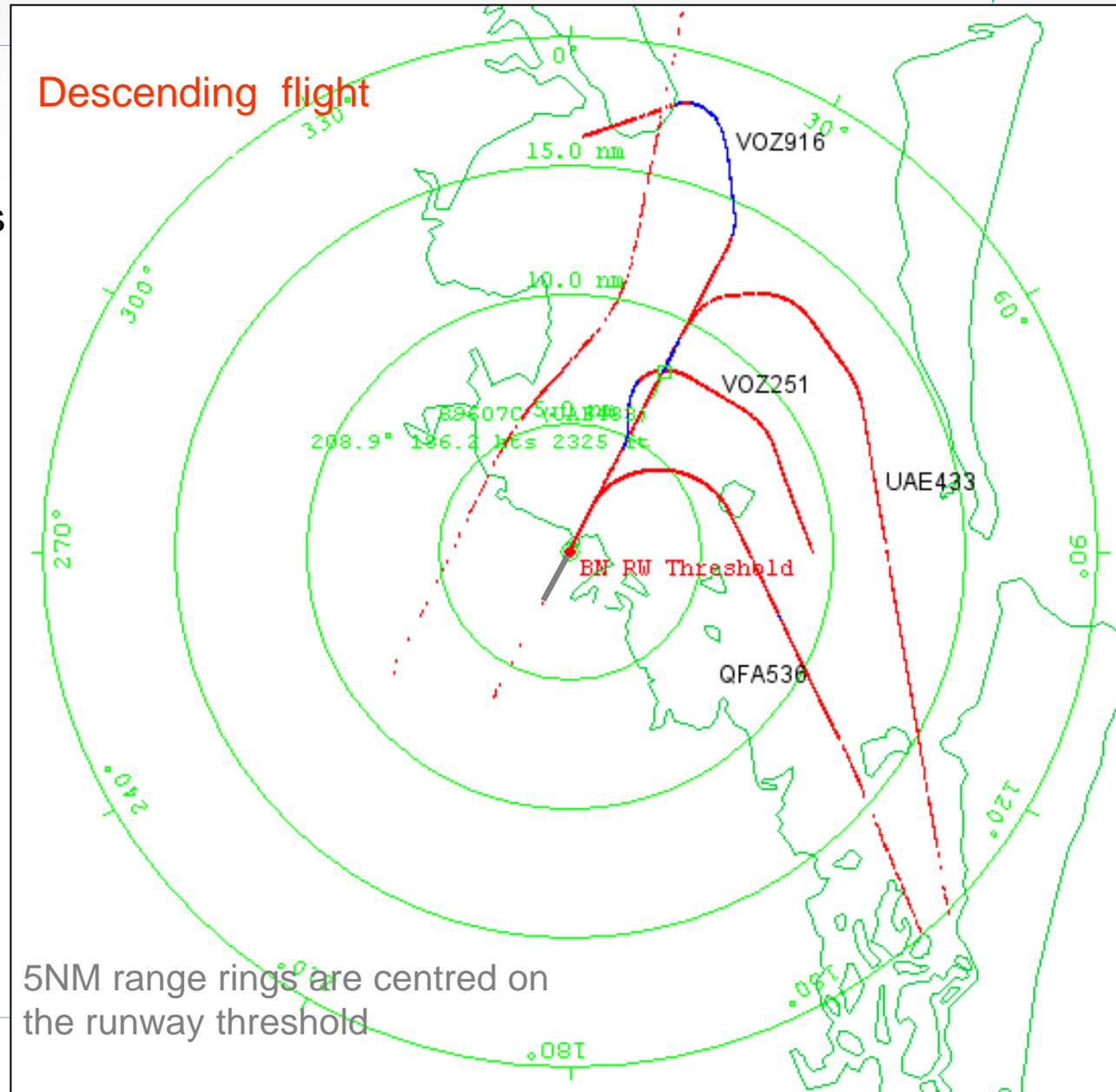
Low Noise

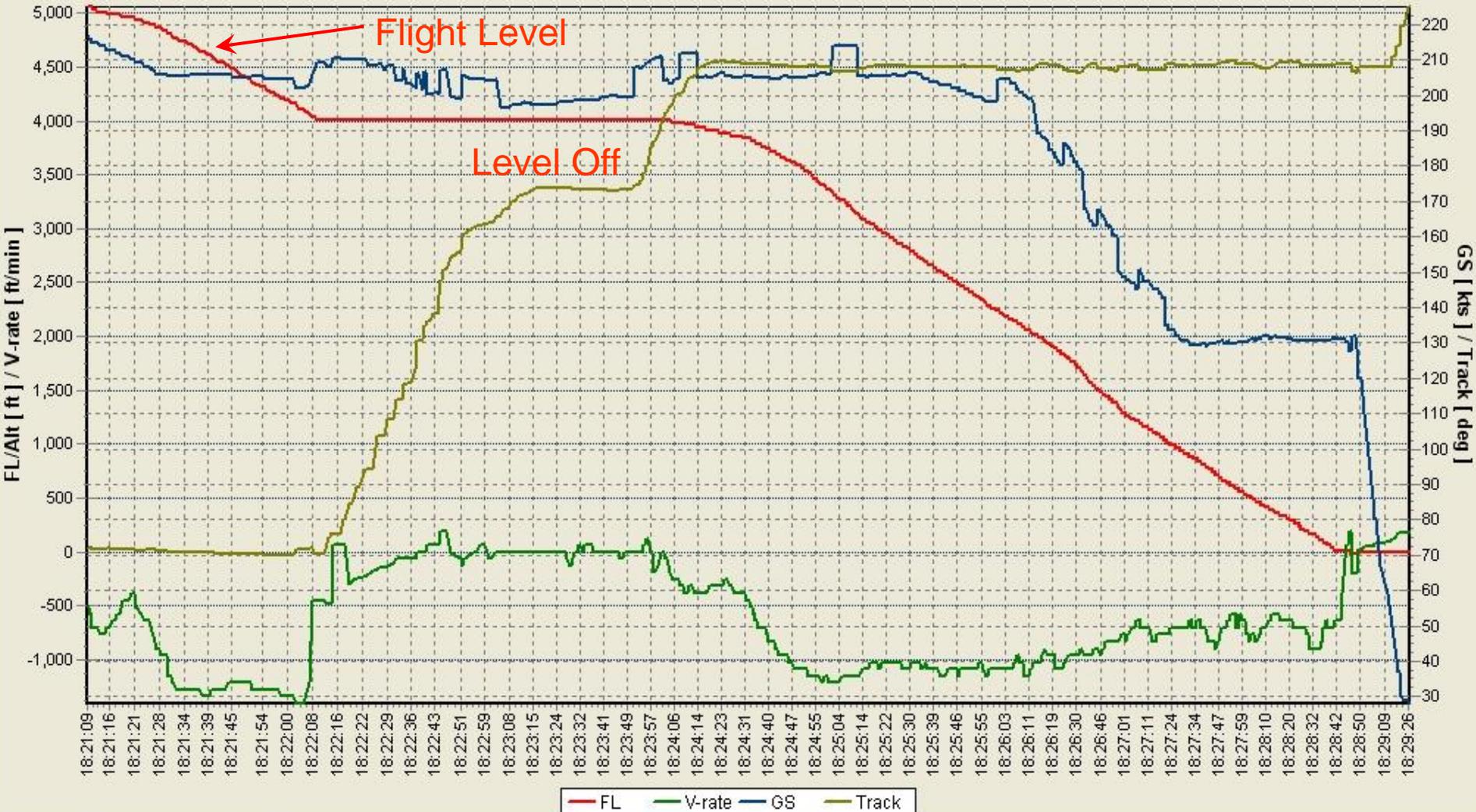
Four Consecutive Arrivals

Instrument weather conditions (IMC)

VOZ & UAE flights RNav onto the ILS

QFA536, a B737-800, conducted an RNP-AR approach

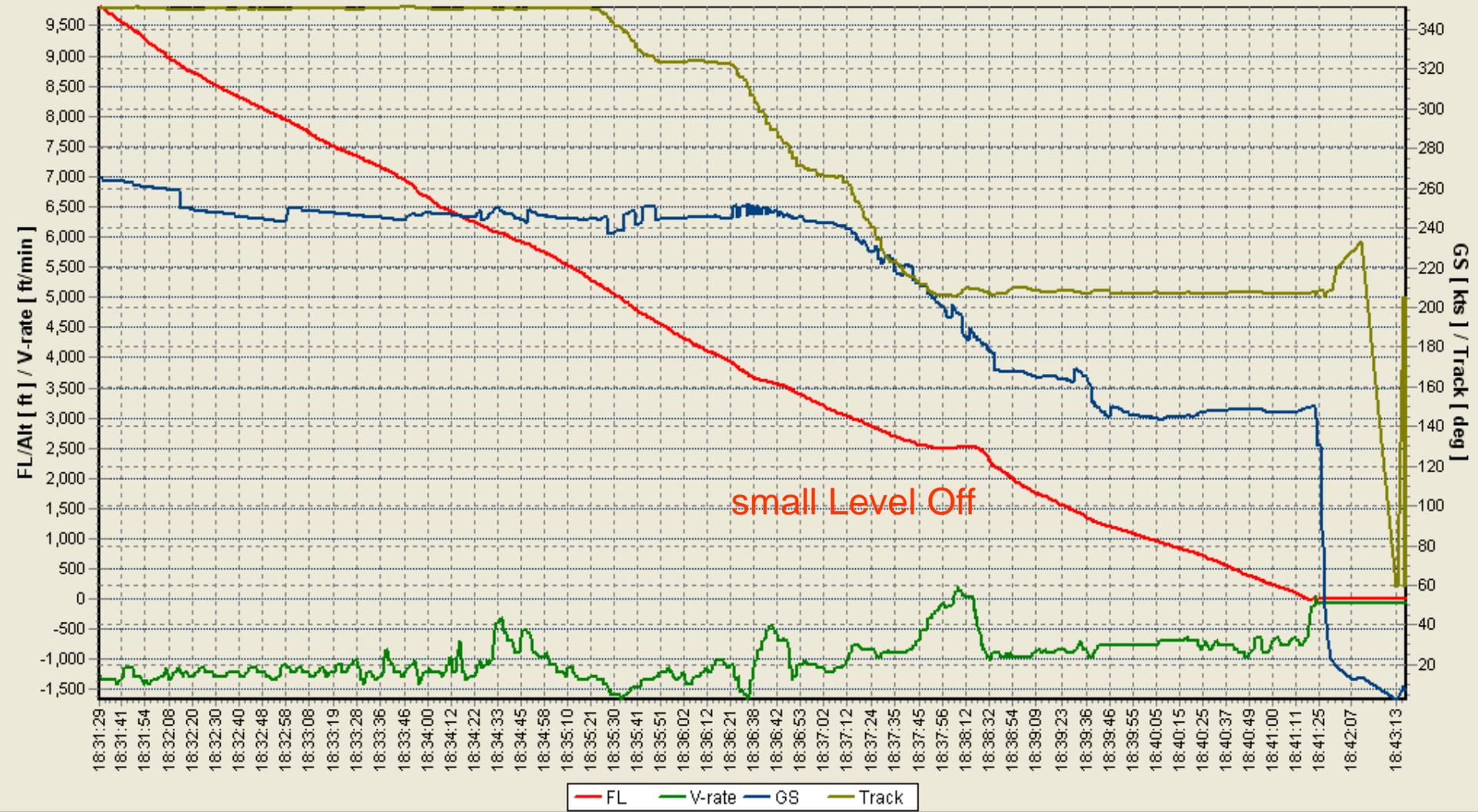




— FL — V-rate — GS — Track

C:\A GENERAL STORE\RNP\B N RNP TRIAL\B N RNP-AR 20070614-182105.bst

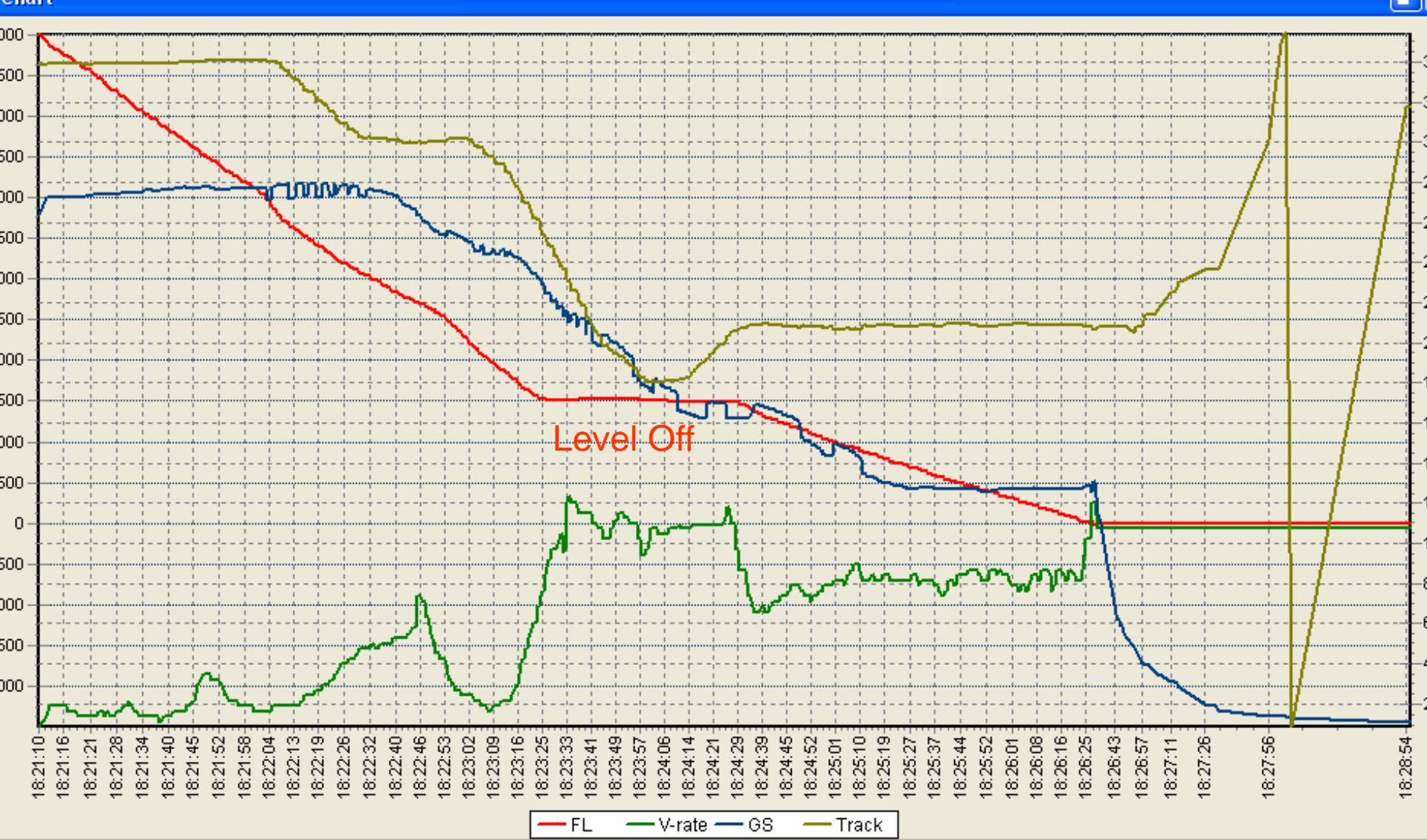
<input type="button" value="Load bst"/>	Select callsign or hex Callsign <input type="radio"/> VOZ916 <input type="button" value="Chart"/>	GE kml <input type="checkbox"/> GE kml <input type="checkbox"/> Flat	QNH <input checked="" type="checkbox"/> QNH adjustment QNH <input type="text" value="1020"/> hPa TA <input type="text" value="10500"/> ft QNH = 1020 185 ft TA = 10500 ft	Plotted flight Callsign VOZ916 Hex 7C6D25 Date 2007/06/14 Start time 21:09 PM End time :29:27 PM Track dist. 488.7 Msg count 752	Flight extremes FL/Alt -15 5,060 GS 28.0 216.6 V-rate -1,408 192 Dist. 8,232.7 8,564.5	<input type="button" value="Save"/>	Route Aircraft data Reg ICAO Type Owner Country
	<input type="button" value="Settings"/>	Recording times Start time 2007/06/14 18:21:09 End time 2007/06/14 18:44:26 Msg count 3974	<input type="checkbox"/> Trk2	Chart control <input checked="" type="checkbox"/> FL <input checked="" type="checkbox"/> GS <input checked="" type="checkbox"/> V-rate <input checked="" type="checkbox"/> Track	X-labels <input type="checkbox"/> Top <input checked="" type="checkbox"/> Bottom		



— FL — V-rate — GS — Track

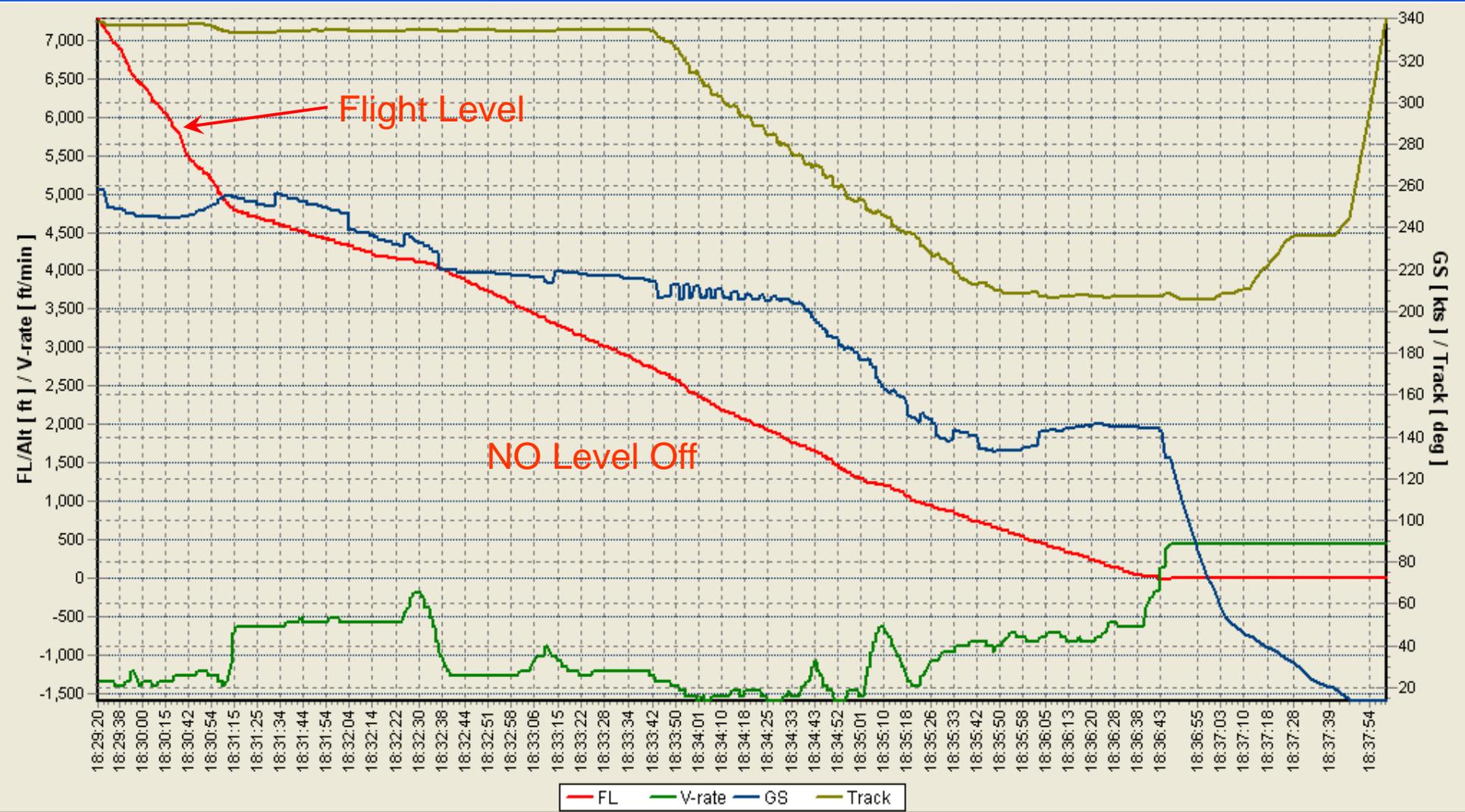
C:\A GENERAL STORE\RNP\BN RNP TRIAL\BN RNP-AR 20070614-182105.bst

<input type="button" value="Load bst"/>	Select callsign or hex Callsign: <input type="text" value="UAE433"/>	GE kml <input type="checkbox"/> GE kml <input type="checkbox"/> Flat	QNH <input checked="" type="checkbox"/> QNH adjustment QNH: <input type="text" value="1020"/> hPa TA: <input type="text" value="10500"/> ft QNH = 1020 185 ft TA = 10500 ft	Plotted flight Callsign: UAE433 Hex: 89607C Date: 2007/06/14 Start time: 31:29 PM End time: :44:09 PM Track dist.: 507.0 Msg count: 918	Flight extremes FL/Alt: -15 9,810 GS: 2.5 264.7 V-rate: -1,664 192 Dist.: 8,232.5 8,561.9	<input type="button" value="GIF"/> <input type="button" value="Save"/> <input type="checkbox"/> Trk2	Route Aircraft data Reg ICAO Type Owner Country
	<input type="button" value="Settings"/>	Recording times Start time: 2007/06/14 18:21:09 End time: 2007/06/14 18:44:26 Msg count: 3974	Chart control <input checked="" type="checkbox"/> FL <input checked="" type="checkbox"/> GS <input checked="" type="checkbox"/> V-rate <input checked="" type="checkbox"/> Track <input type="checkbox"/> Top <input checked="" type="checkbox"/> Bottom				



GENERAL STORE\RNP\BNN RNP TRIAL\BNN RNP-AR 20070614-182105.bst

Select callsign or hex Callsign <input type="radio"/> VOZ251 <input type="button" value="Chart"/> Hex <input type="radio"/>	GE kml <input type="checkbox"/> Flat <input type="checkbox"/>	QNH <input checked="" type="checkbox"/> QNH adjustment QNH 1020 hPa TA 10500 ft QNH = 1020 185 ft TA = 10500 ft	Plotted flight Callsign VOZ251 Hex 7C6D28 Date 2007/06/14 Start time 21:10 PM End time :28:57 PM Track dist. 508.6 Msg count 599	Flight extremes FL/Alt -15 6,010 GS 11.0 279.7 V-rate -2,496 320 Dist. 8,232.5 8,557.8	GIF <input type="button" value="Save"/> Trk2 <input type="checkbox"/>	Route Aircraft data Reg ICAO Type Owner Country
Recording times Start time 2007/06/14 18:21:09 End time 2007/06/14 18:44:26	Msg count 3974	Chart control <input checked="" type="checkbox"/> FL <input checked="" type="checkbox"/> GS <input checked="" type="checkbox"/> V-rate <input checked="" type="checkbox"/> Track	X-labels <input type="checkbox"/> Top <input checked="" type="checkbox"/> Bottom			



C:\A GENERAL STORE\RNP\BN RNP TRIAL\BN RNP-AR 20070614-182105.bst

<input type="button" value="Load bst"/>	Select callsign or hex Callsign <input type="radio"/> QFA536 <input type="button" value="Chart"/>	GE kml <input type="button" value="GE kml"/>	QNH <input checked="" type="checkbox"/> QNH adjustment QNH <input type="text" value="1020"/> hPa TA <input type="text" value="10500"/> ft QNH = 1020 185 ft TA = 10500 ft	Plotted flight Callsign QFA536 Hex 7C6DB8 Date 2007/06/14 Start time 29:20 PM End time :38:01 PM Track dist. 485.4 Msg count 692	Flight extremes FL/Alt -15 7,285 GS 13.5 258.9 V-rate -1,600 448 Dist. 8,232.5 8,554.7	<input type="button" value="GIF"/>	Route
	<input type="button" value="Settings"/>	Recording times Start time 2007/06/14 18:21:09 End time 2007/06/14 18:44:26 Msg count 3974	<input type="checkbox"/> Flat	<input type="checkbox"/> Trk2	<input type="button" value="Save"/>	Aircraft data Reg ICAO Type Owner Country	

Brisbane TMA RNP-AR Ops

24 Months of Operations

Two aircraft types (B738 & A320)

Track Keeping:

- 7,532 flights (2,404,276 data points) analysed
- Straight flight – 20m (1 std dev)
- Manoeuvring – 42m (1 std dev)
- B737-800 wingspan 36m



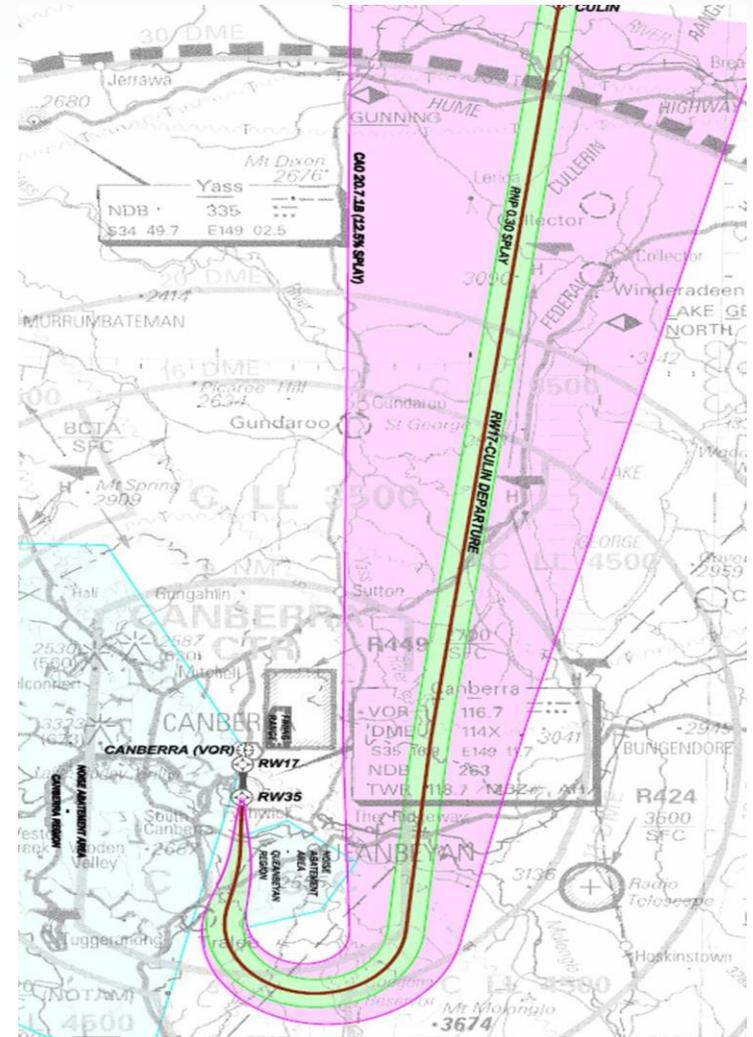
Economic Savings

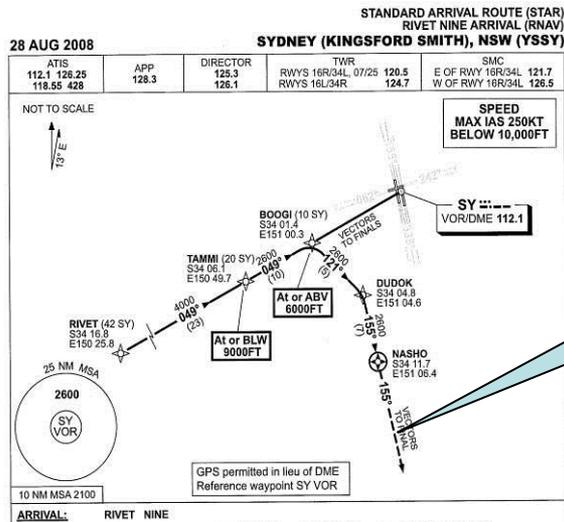
- 3,200 RNP Arrival/Approach otherwise ILS (due weather)
- 55,946 track miles avoided; 699,325 kg fuel saved
- 2,237,840 kg CO2 not emitted
- PLUS efficiency of Continuous Descent Arrival/Approach

In routine daily use at 16 airports; typically 110 operations per day

RNP Departures

- Terminal Procedures assure terrain clearance
- Area assessed depend on Navigation Accuracy & Integrity
- High Accuracy / Integrity allows going around high terrain (not over)
- Allows greater payload





VECTORS TO FINAL

5 Nm Rings

Sydney



2 aircraft tracks

- 4 Dimension Trajectory Management
- Path to threshold known at TOD
- Required time of Arrival (RTA)
- use FMS to optimise aircraft operation
- ATC Flow Modelling & Management
- More accurate TMA wind information

Track Spread

RNP / APV Arrival – GLS Approach



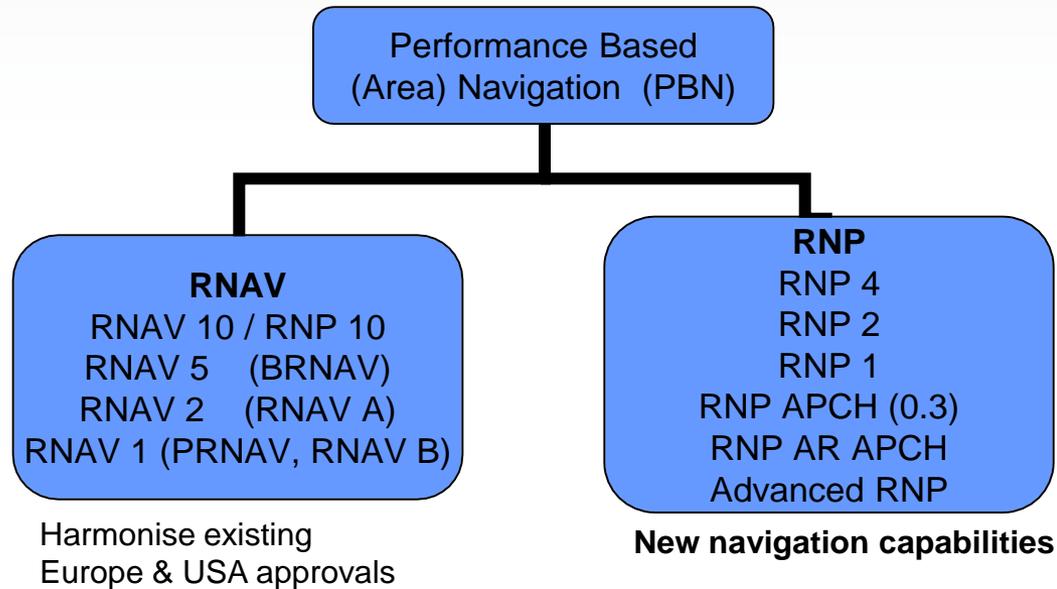
Model ARL 1900



SLS-4000 GBAS

The more efficient green RNP/APV - GLS guided procedure compared to typical vectored red track currently used at Sydney.

Performance Based Navigation (PBN)

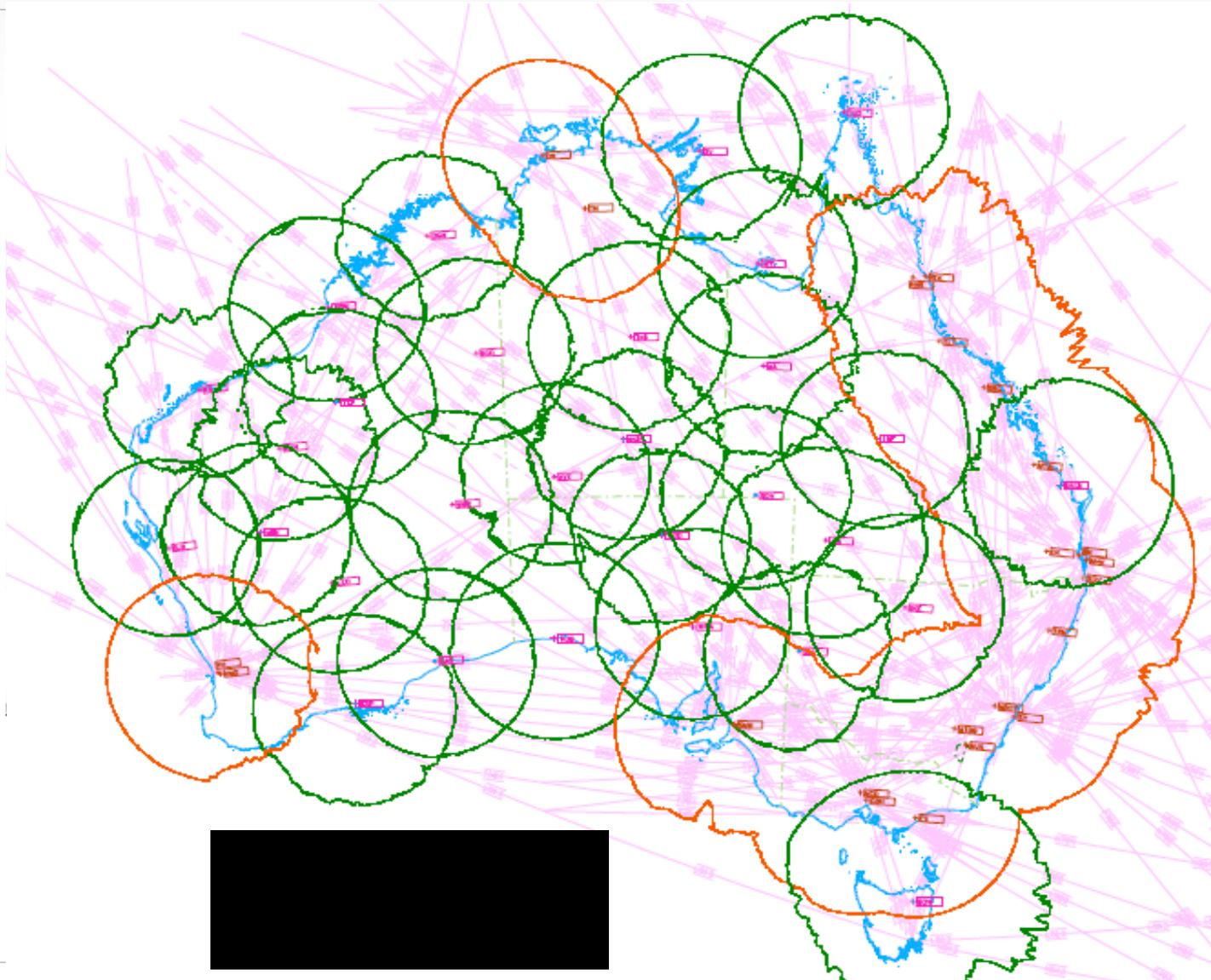


Oceanic: RNP-4 RNAV-10 protracted transition
En Route: RNP-2 RNAV-5 transition within radar
Arrival: RNP-1 RNAV-1 for short transition
NPA: RNP-APCH / RNAV(GNSS)
Specialised: RNP Special at Operator Request

GPS is a powerful enabling technology

-
- Australian Aviation Context
 - GPS and Aircraft Navigation
 - **GPS and Aircraft Surveillance**
 - Fitment Mandates in Australia
 - Thanks and Thoughts

ADS-B above FL 290

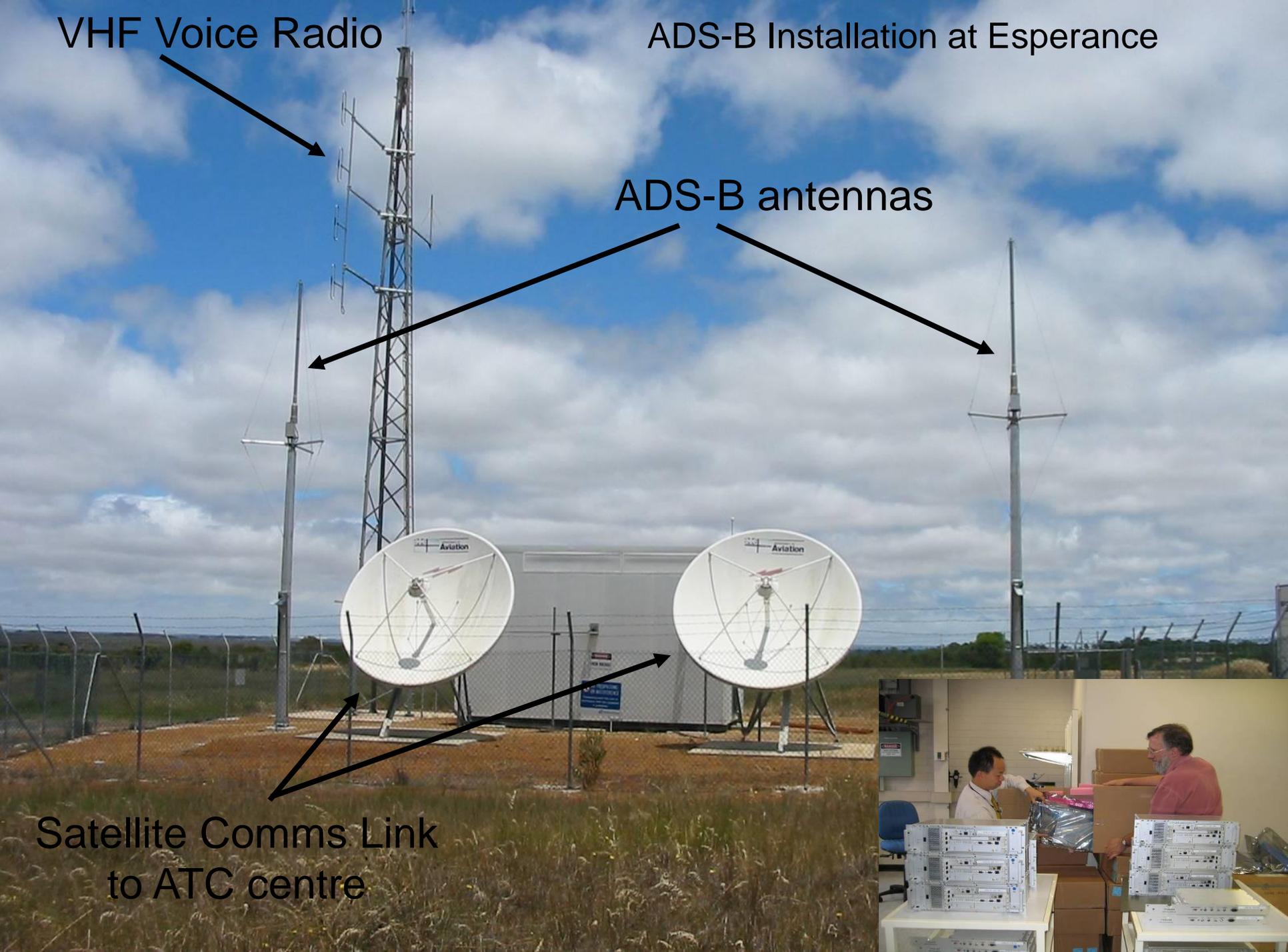


VHF Voice Radio

ADS-B Installation at Esperance

ADS-B antennas

Satellite Comms Link
to ATC centre



ADS-B Installation at Longreach





Some ADS-B installations are in remote areas



ADS-B cohabitates with other services

ATC Feedback



Greater probability of optimum altitude

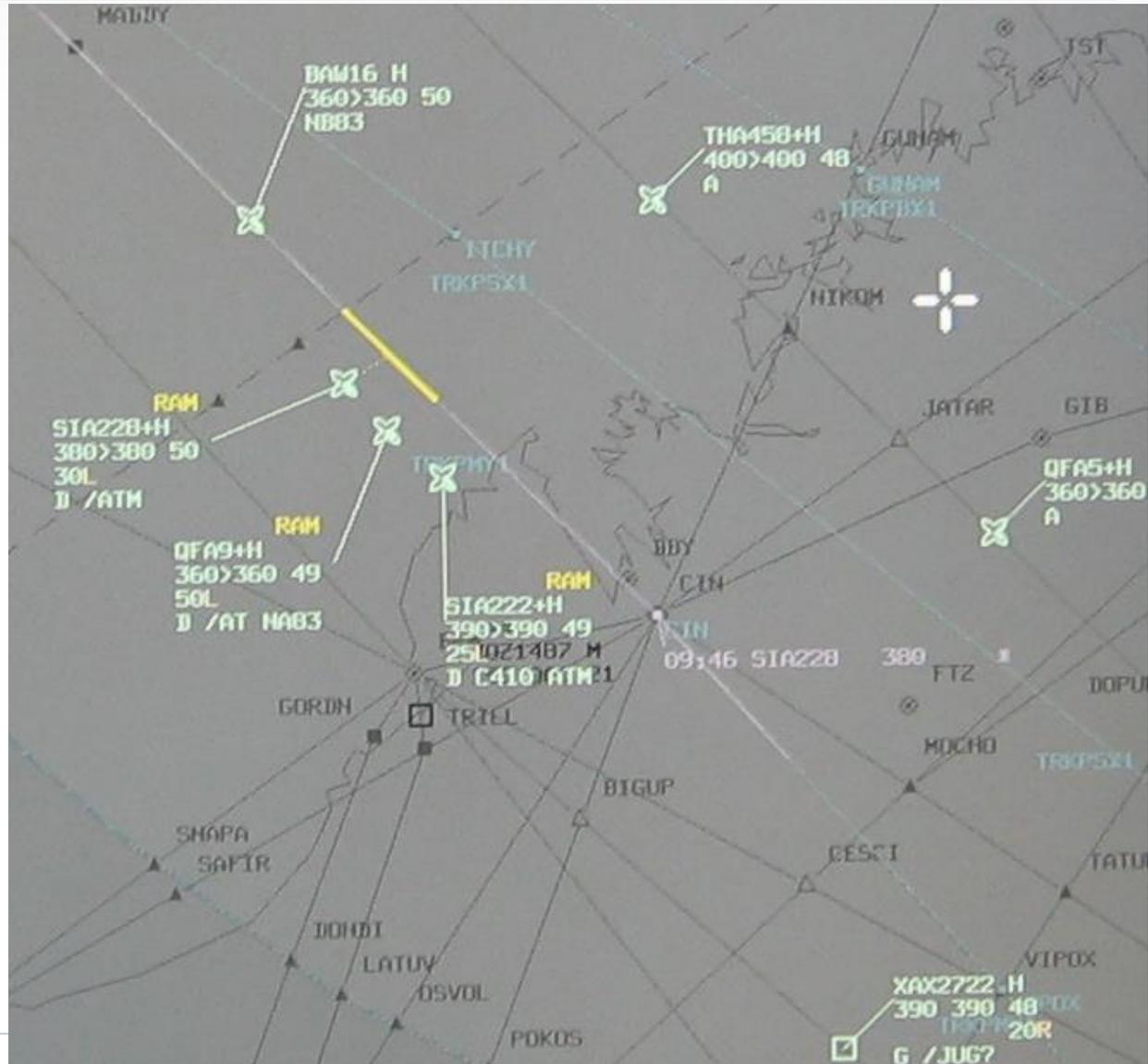
Flexibility to accommodate weather

Less ATC intervention

Greater visibility increases Safety

55% of Domestic Flights

91% of International Flights



READY FOR

ADS-B



Airservices congratulates Alliance Airlines on forward fitting ADS-B technology to its fleet of Fokker 100s operating in Western Australia.

They're already seeing the benefits of an increase in safety and better service to their customers.

By 2017 all Australian registered IFR aircraft flying in Australia's airspace will be required to operate using ADS-B.

For more information, visit www.airservicesaustralia.com/projects/ads-b

airservices
connecting australia

Alliance Airlines paves the way for early ADS-B fitment

24-04-2012 - Alliance Airlines has fitted automatic dependant surveillance broadcast (ADS-B) technology to four of its Fokker 100 aircraft operating in Western Australia, paving the way for the forward fitment to the remainder of its fleet.

ADS-B is a satellite-based traffic surveillance technology that enables aircraft to be accurately tracked by air traffic controllers and other pilots without the need for conventional radar.

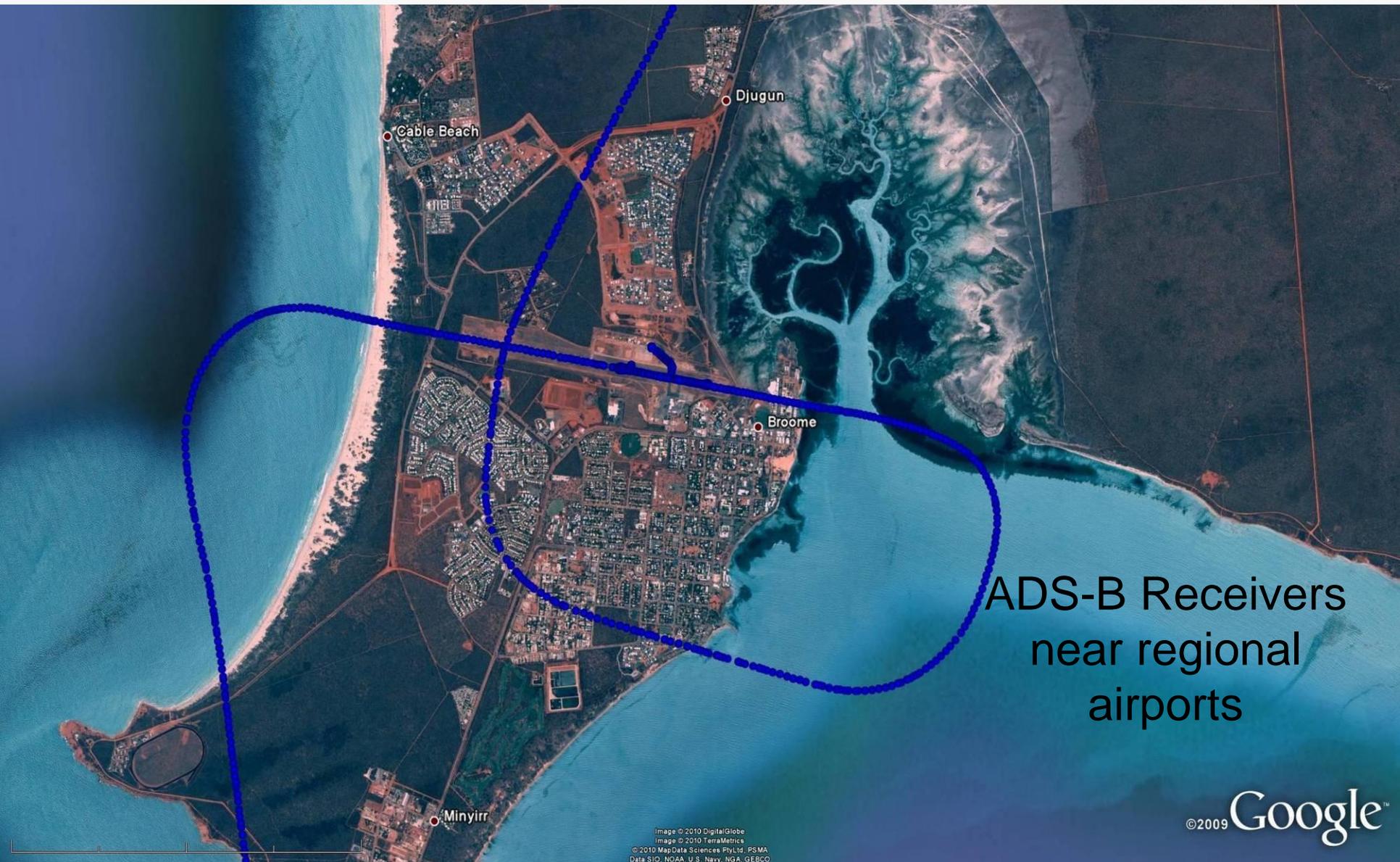
Airservices Australia, the country's air navigation services provider, continues to urge airlines and operators to fit their aircraft with ADS-B sooner rather than later, noting those who have are already seeing the benefits.

"Like many operators, we were suffering from the heavy congestion in areas of Western Australian airspace and we saw ADS-B as a solution," said Alliance Airline's Managing Director, Scott McMillan.

"It's been very quick to see the savings from ADS-B, not only from a cost point of view but it also has meant an increase in safety and better service to our customers. I expect our remaining Fokker 100s will all be fitted by the end of this year – a year ahead of the mandate."

Oceanic Route Crossings





ADS-B Receivers
near regional
airports

-
- Australian Aviation Context
 - GPS and Aircraft Navigation
 - GPS and Aircraft Surveillance
 - **Fitment Mandates in Australia**
 - Thanks and Thoughts

PBN IFR Navigation:

- Using GPS as enabling technology
- Forward fit: 6 Feb 2014; Retrofit: 4 Feb 2016

ADS-B Out

- Aust aircraft operating at/above FL290: 12 Dec 2013
- IFR Aircraft registered on/after 6 Feb 2014
- IFR Aircraft registered before 6 Feb 2014 retrofit 2 Feb 2017

Navigation & ADS-B Carriage Requirements:

- <http://www.comlaw.gov.au/Details/F2012L01739/Download>

PBN Approval Requirements:

- <http://www.comlaw.gov.au/Details/F2012L01570/Download>

ARE YOU FITTED?

ADS-B



Mandatory fitment deadlines for ADS-B technology in Australian airspace are fast approaching.

Where do you fit?	On or after	Requirement
All flights at/above FL290	12 December 2013	Must be ADS-B capable
Addition to Australian register	6 February 2014	Must be ADS-B capable GNSS navigation required
Replacement transponder	6 February 2014	Must be ADS-B transponder
Operating 500NM from Perth	4 February 2016	Must be ADS-B capable
IFR aircraft (aerial work/private operations)	4 February 2016	GNSS navigation required
Operate to BNE, SYD, PER or MEL	4 February 2016	Mode S transponder required
All IFR aircraft	2 February 2017	Must be ADS-B capable

www.airservicesaustralia.com/projects/ads-b/other-mandates-2014-2017

-
- Australian Aviation Context
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 - GPS and Aircraft Surveillance
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GPS improved with time:

- Robustness - 27 Satellite geometry
- Accuracy - Equivalent User Range error decreased
- Availability – Practical Purposes 100%

Women and Men who pioneered / operate GPS:

- You have our Sincere thanks for the truly exceptional Service

Politicians & Administrators:

- GPS gives immense Safety, Environment and Economic benefit
- Ubiquitous in all aspects of life
- Easy to take for granted
- GPS needs to be protected, fostered, replenished, grown



Ed Williams Airservices Australia

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