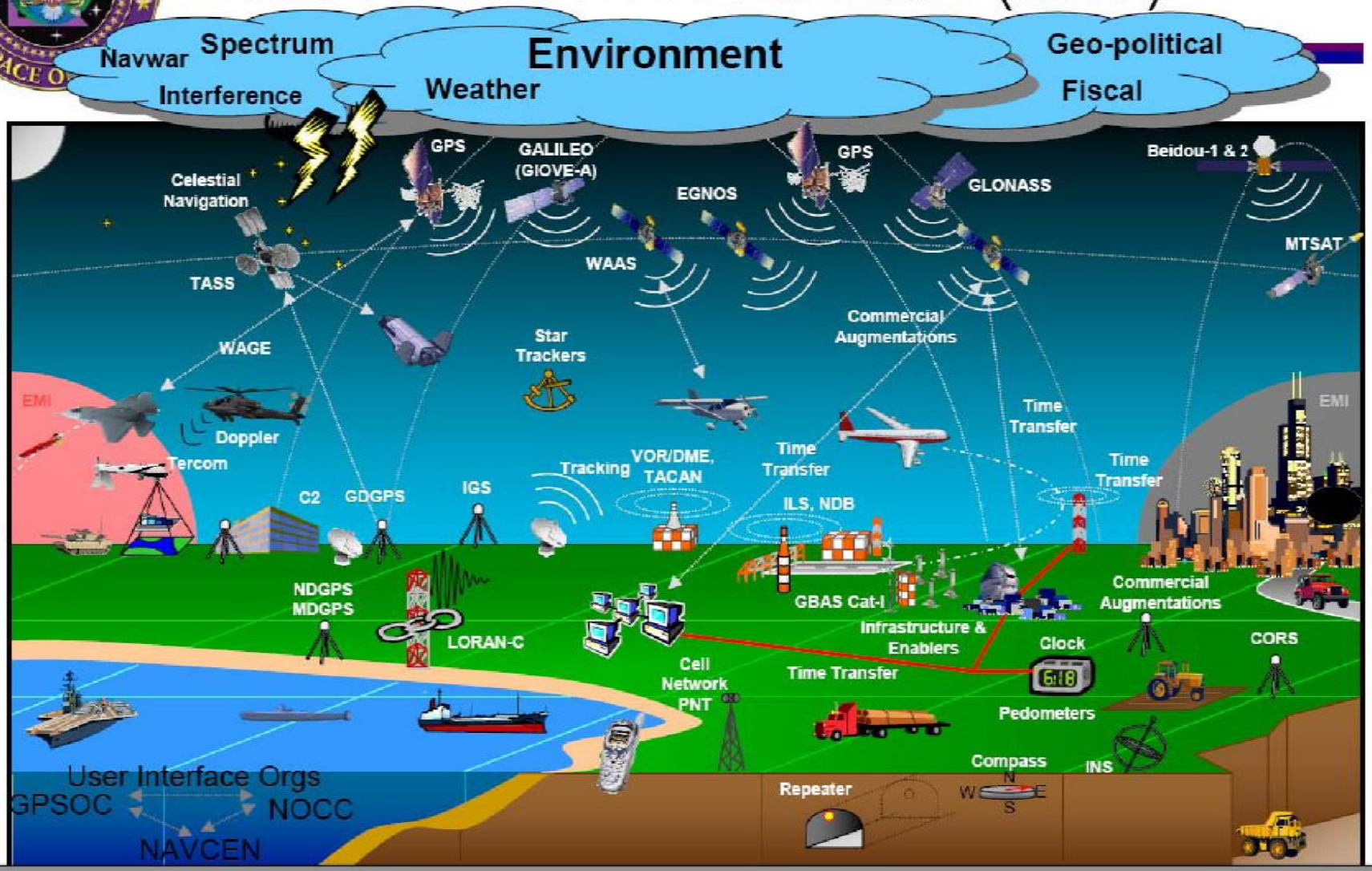
Australian CNS/ATM Transition

PBNICG March 2016

Ian Mallett

safe skies for all

Draft "As-Is" PNT Architecture (2007)



Standards Reference Frames Cryptography Science & Technology USNO NIST NGA NGS
Star Catalogs Launch **ENABLERS & INFRASTRUCTURE** NSA Industrial Base
Electro Optical Info. Modeling Mapping/Charting/Geodesy Laser Ranging Network Policies Testing

Australia

2000 NM
Skybury Plantation is up here
Mountain T
is in the
Potential Coffee La
NORTHERN TERRITORY
WESTERN AUSTRALIA
SOUTH AUSTRALIA
QUEENSLAND
NEW SOUTH WALES
VICTORIA
TASMANIA
A.C.T.
GREAT SANDY DESERT
TANAMI DESERT
GIBSON DESERT
GREAT VICTORIA DESERT
NULLARBOR PLAIN
GREAT AUSTRALIAN BIGHT
SOUTH PACIFIC
TASMAN SEA
BASS STRAIT
PAPUA NEW GUINEA
PERTH
ADELAIDE
MELBOURNE
SYDNEY
BRISBANE
CANBERRA
HOBART
Alice Springs
AUSTRALIA
EDITION 1
Simple Conic Projection
0 200 400 kilometres
HYPSOMETRIC TINTS
BATHYMETRIC TINTS
2000 1500 1000 500 200 0 200
Heights and depths are shown in metres
Populated places
Greater than 1 000 000
100 001 - 1 000 000
20 000 - 100 000
Less than 20 000
Road, principal
Selected railways
Spot elevation
State boundary
River, perennial
River, non-perennial
Lake, perennial
Lake, non-perennial
Reef

The Australian Context

Diverse Operating Environment

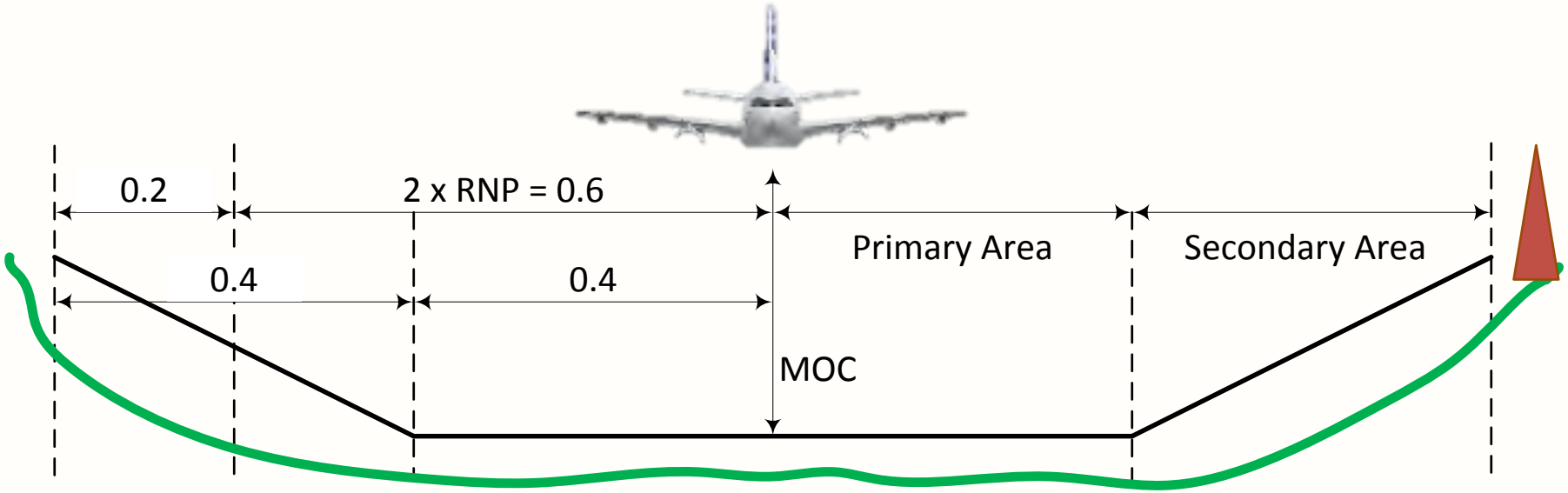
- Sparsely populated continental land mass:
  - Ranges from equatorial/tropical through desert to temperate climate.
  - 80% of the population lives within 200 km of the coast.
  - Diverse airspace structure:
    - Remote areas with little infrastructure.
    - Sydney – Melbourne is the third busiest route in the world.
  - High level of GA activity serving remote communities.
- Small infrastucture.

GPS Primary Means

- For 70 years the minimum navigation requirement was a single ADF and NDB.
- Safety case developed that shows that TSO C146 with FDE exceeds the minimum performance of the ADF and NDB.
  - TSO C129 fails because of FD only.
  - Actual GNSS performance >3 times better than specification.

RNP AR Basics

RNP APCH Final Segment



RNP AR operations are not like

But certification requirements are not far from assuming such situations

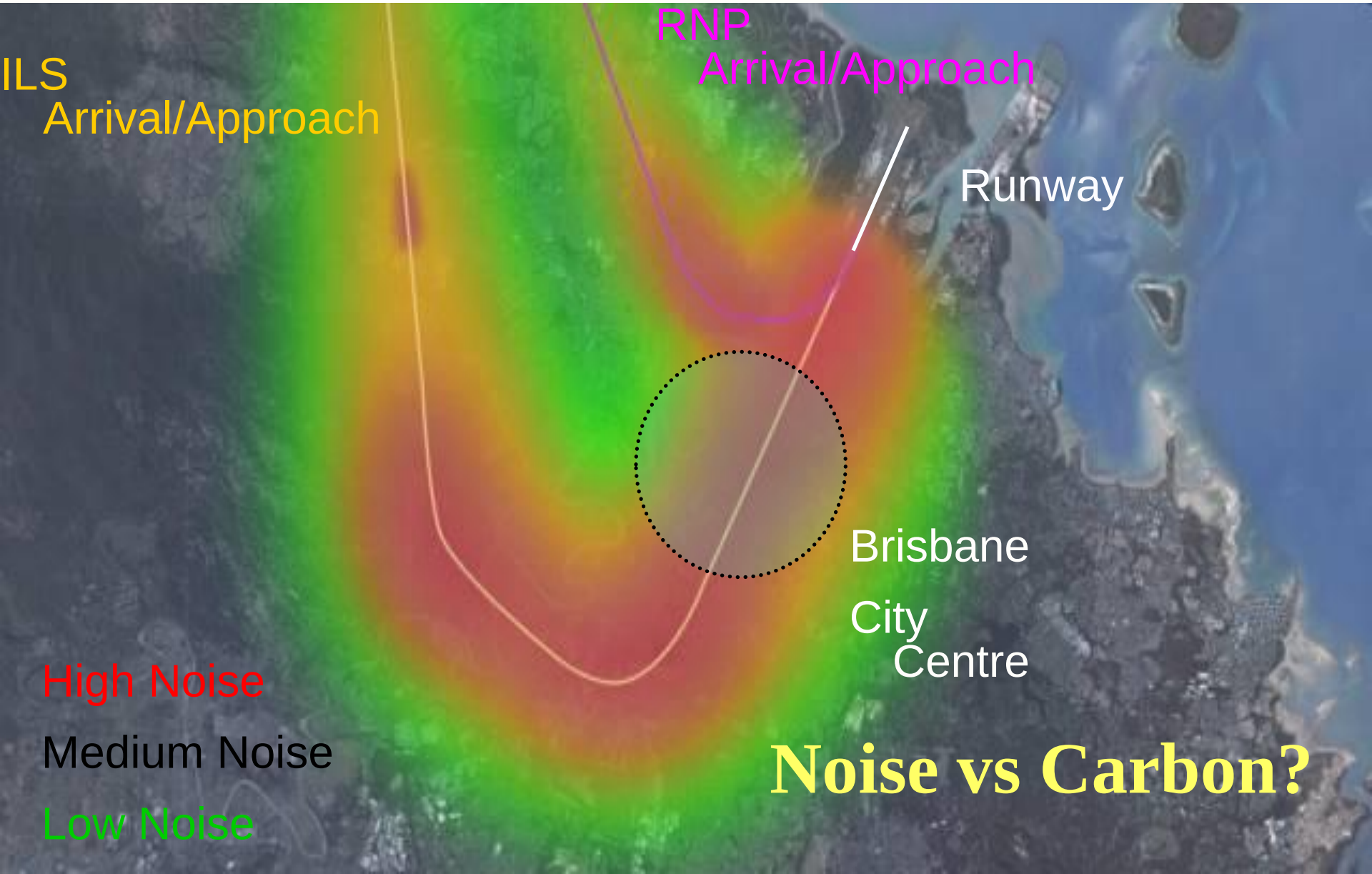
RNP AR Procedures

- Procedures are identified as RNAV (RNP) with the limitation “CASA authorised operators only”.
- RNP AR operations are limited to operators with high capability aircraft.
- RNP AR authorisations have substantial overheads for authorised operators:
  - Aircraft dual equipment requirements: GNSS, inertial, FMS, EFIS displays, Baro-VNAV with additional requirements.
  - Crew training, competency and currency.
  - Navigation database validation.
  - Data recording and analysis.

RNP AR Operations

- RNP AR APCH allows RF legs after the FAF.
- Buffers are reduced to 2 x RNP only.
- Can be ICAO Doc 9905 or “special” or “proprietary”.
  - Proprietary are special designs specific to aircraft type.
  - OEI procedures may be included in proprietary procedures.
    - OEI departures can have significant payload benefits.

PBN at Work


RNP
Arrival/Approach
ILS
Arrival/Approach
Runway
Brisbane
City
Centre
High Noise
Medium Noise
Low Noise
Noise vs Carbon?


184
138
231
0000

Why GNSS based PBN?

- TSO C145 & C146 GNSS provides the ability to utilise satellite based technology:
  - Little ground infrastructure required.
  - Flexible airspace design.
  - GPS facilitates year round access to remote communities.

Transition to PBN

- Airspace will become RNP 2 en route and RNP 1 for terminal operations from 4 February 2016.
- 26 May 2016 AIRAC cycle will implement route changes for decommissioned navigation aids.
  - 181 of 415 navigation aids will be decommissioned.
    - Refer to the Airservices website for the aids to be decommissioned.

Applicable Regulations

- CAO 20.18 specifies the aircraft equipment requirements:
  - Clause 9B specifies the carriage and use of ADS-B;
  - Clause 9C sets the technical standards for Mode S transponder equipment;
  - Clause 9D specifies the carriage and technical standards for GNSS equipment;
  - Clause 9E specifies the carriage and use of Mode S transponder equipment.
- CAO 20.91 specifies the requirements for Performance-based Navigation.

GNSS Deeming Provisions

- CAO 20.91 clauses 9, 10 and 11 deem that GNSS equipped aircraft with AFM approvals or meeting AC 21-36( ) or CAAP 35-1 are authorised for some PBN operations:
  - RNAV 5, RNAV 1 and RNAV 2; RNP 2, RNP 1 and RNP APCH – LNAV are addressed.
  - Capability depends on installation (TSO C129 v C146).
- Deeming is based on previously demonstrated compliance:
  - The aircraft is compliant and the crew are suitably authorised and current.

Aircraft with Integrated Avionics Systems

- The deeming provisions provide for aircraft equipped with Integrated Avionics Systems using GNSS only for area navigation to be considered as being equipped with stand-alone GNSS systems.
  - Provision added since some integrated systems have TSO C145 GNSS sensors.
- Aircraft with multi-sensor FMS are not covered by the deeming provisions.

Impact on VFR Operators

- Not a lot!
- If a transponder installation is replaced with a new one, it must be ADS-B capable Mode S.
- Aircraft operating at Brisbane, Sydney Melbourne or Perth aerodromes must be equipped with an ADS-B capable Mode S transponder.
- Significant number of VFR aircraft fitted

Selection of Navigation Specifications

- Original en route selection was RNAV 5:
  - Impractical due to redesign requirement to address LSALT.
    - Route LSALT would increase up to 2000 ft in the south-east.
- RNP 2 selected to mitigate the LSALT problem:
  - LSALT conservative but safe.
  - LSALT will be assessed for routes during routine review.
- RNP 1 selected for terminal procedures (SIDs & STARs).

Foreign Operator Authorisations

- Foreign NAAs not able to issue RNP 1 and RNP 2 authorisations due to:
  - RNP 1 and RNP 2 airworthiness compliance statements in the AFM.
  - Foreign NAAs did not have published requirements for RNP 1 and/or RNP 2.
  - Foreign NAAs did not have a regulatory means of issuing RNP 1 and/or RNP 2 authorisations.

CASA RNAV 1 & RNAV 2 Exemption

- Performance and function requirements of RNAV 1 & RNAV 2 are the same as RNP 1 and RNP 2 (excluding optional functions).
- CASA Exemption 06/16 approved:
  - Operators holding home State GNSS based RNAV 1 & RNAV 2 authorisation can operate on Australian RNP 1 and RNP 2 procedures and routes respectively.
  - Operators must advise CASA International Operations of intent to utilise the exemption.
  - Exemption expires on 31 January 2018:
    - Operators require RNP 1 and RNP 2 authorisations from this date.

Back-up Navigation Network

- Beginning 4 February 2016 the Back-up Navigation Network (BNN) will be progressively implemented.
  - 250 navigation aids (NDB and VOR) will be decommissioned.
- Route structures and waypoint names will change with BNN implementation.
  - Application of waypoint names has implications e.g. aerodrome ARP as en route waypoints.
    - Issue being raised in ICAO.

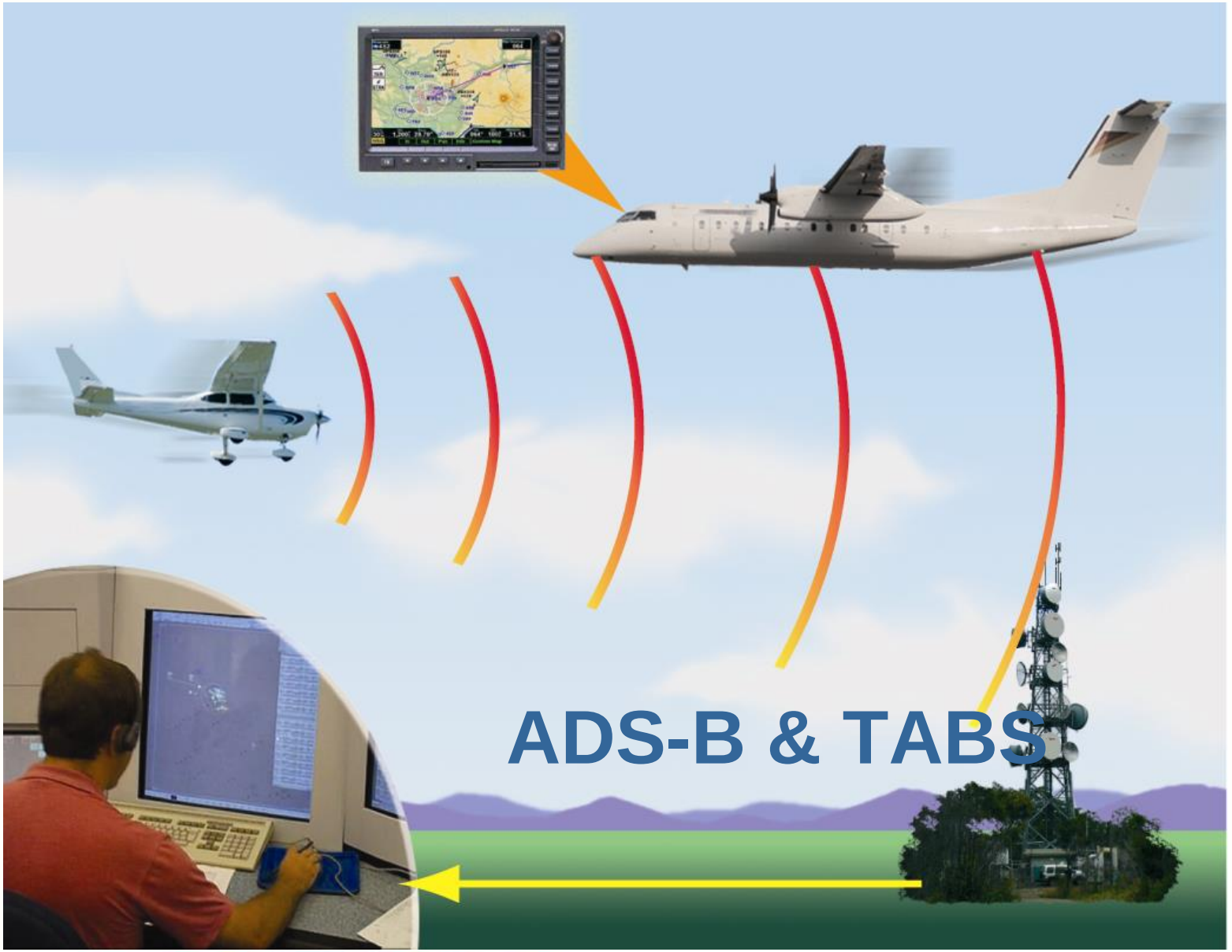
GNSS Mandates

- IFR aircraft registered on or after 6 February 2014 must be equipped with TSO C145, C146 or C196 GNSS.
- Aircraft modified on or after 6 February 2014 must be equipped with TSO C145, C146 or C196 GNSS.
  - Requirement is applicable to new or replacement installations, not repair of existing installations.
- From 4 February 2016:
  - All IFR aircraft must be equipped with TSO C129, C145, C146 or C196 GNSS.

RESOLUTION A37-11

- 15% of aircraft are Baro-VNAV capable
  - Carry 95% of passengers!
  - RNP-AR, GLS
  - Baro-VNAV at ILS equipped aerodromes
  - Progressive role out to suitable aerodromes
  - Not all aerodromes will have 3D approach
- **Safety Issue** – Confusion over 2D/3D approaches
  - LNAV+ V is a 2D approach – pilot responsible for altitude
  - LNAV/VNAV is a 3D approach
- SBAS in Australia – still being investigated

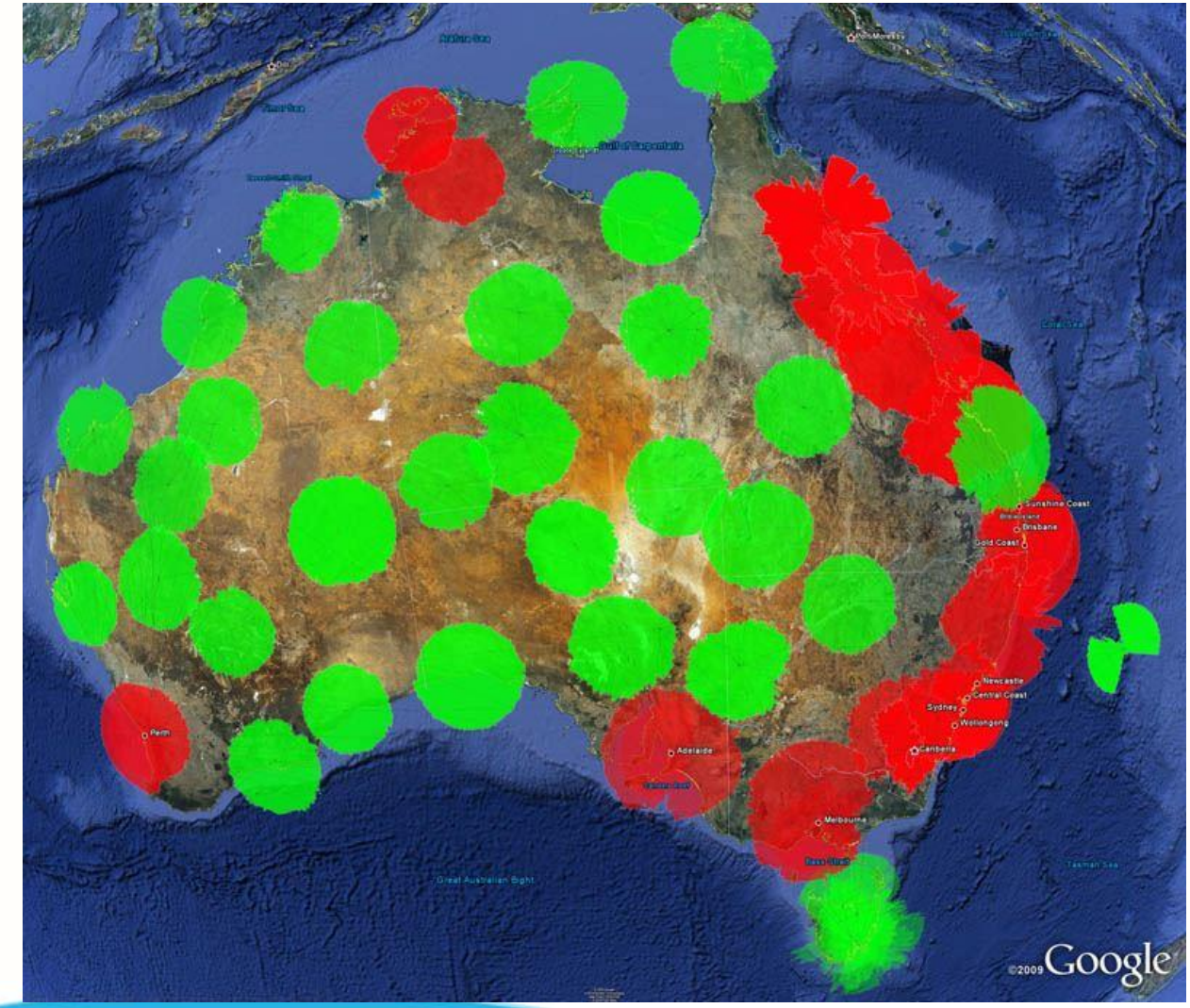
GLS SYDNEY – Dec 2012


ADS-B & TABS

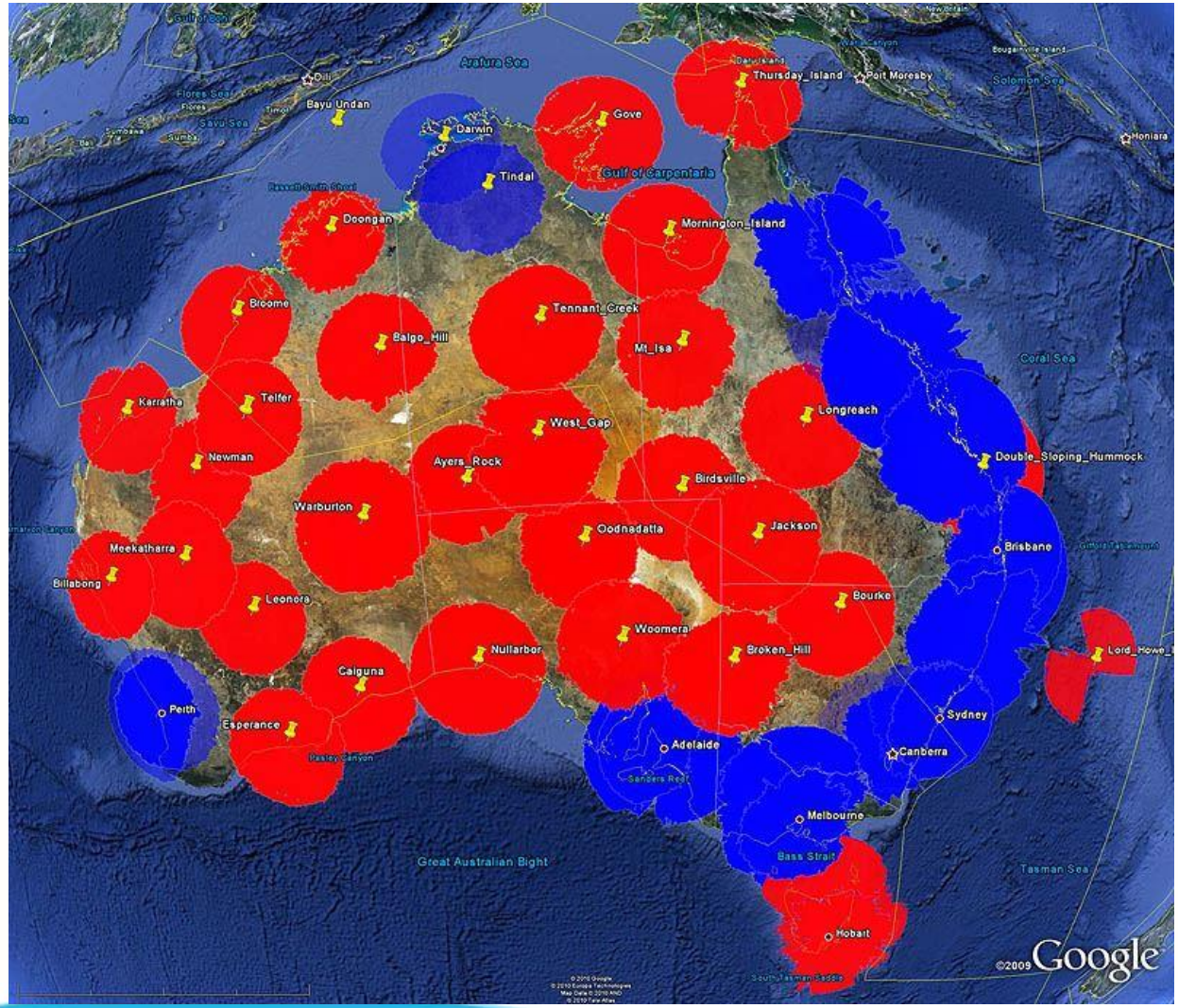
ADS-B Mandates

- From 6 February 2014:
  - IFR aircraft registered on or after this date must be equipped with TSO C166 ADS-B (RTCA DO-260).
  - Aircraft modified on or after 6 February 2014 must be equipped with TSO C166 ADS-B (RTCA DO-260).
  - IFR aircraft operating in Class A, B, C or E airspace within 500 NM quadrant north and east of Perth airport require ADS-B (does not include foreign operators).
- From 2 February 2017 all IFR aircraft must be equipped with TSO C166 ADS-B (RTCA DO-260).

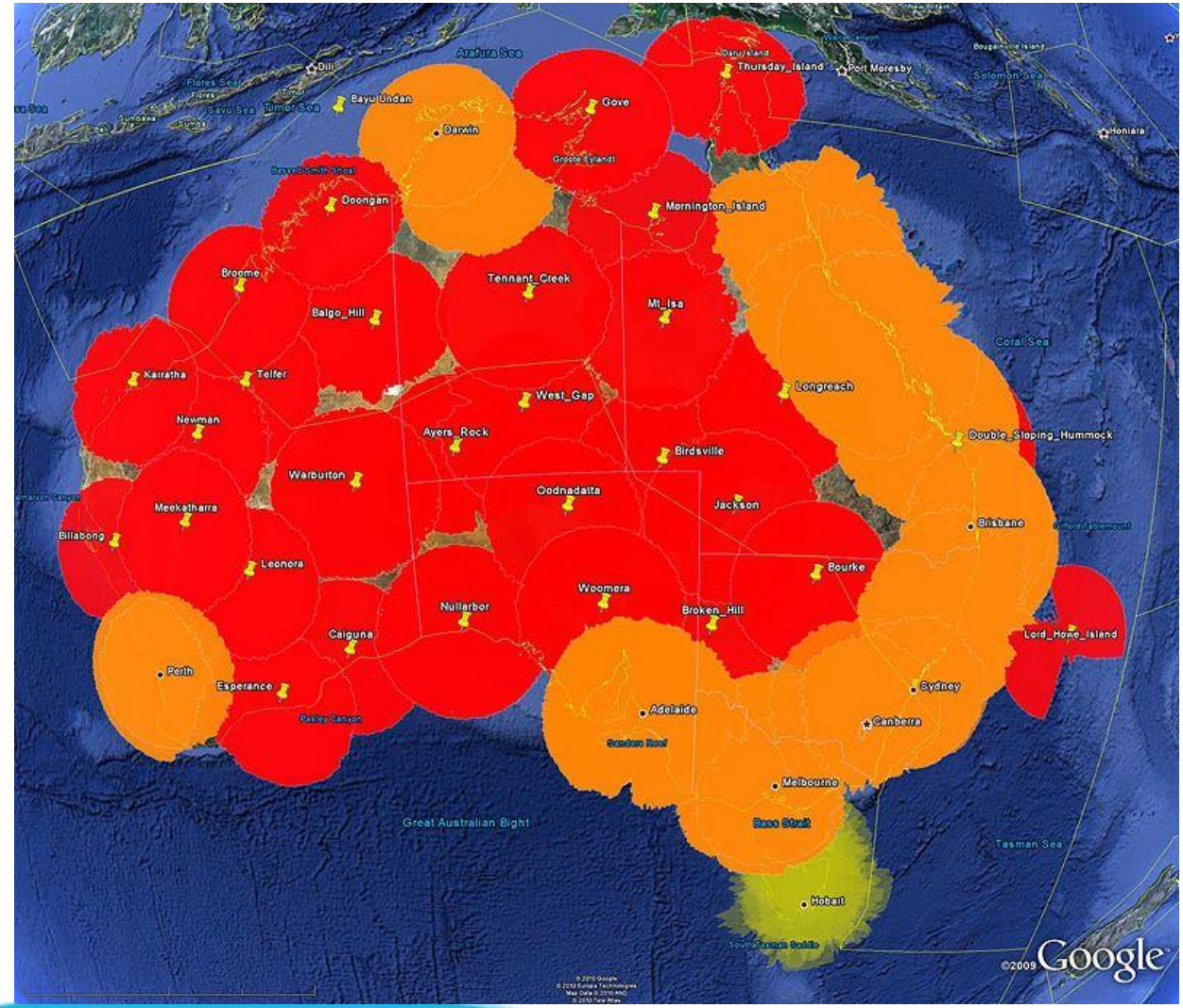
5,000 ft Coverage



10,000 ft Coverage



20,000 ft Coverage



ADS-B Installation Options

- Operators may:
  - Install an ADS-B capable Mode S transponder and connect a TSO C145a, C146a or C196 GNSS.
    - The GNSS may be part of the aircraft navigation suite or a stand-alone receiver.
  - Install a stand-alone ADS-B system that has an integral Mode S transponder and GNSS.

ADS-B Installation Issues

- System testing: an approved ADS-B test set must be used for testing.
  - Flight Radar 24 is not an approved test set.
  - The transmitted signal must be compliant.
- System configuration:
  - 24-bit Mode S code – wrong codes are common;
  - Flight ID – must not have ‘VH’ for domestic operations;
  - Source Integrity Level – must be 2 or 3 for ADS-B.
- Australia uses the 1090 MHz Extended Squitter:
  - US UAT based ADS-B will not work in Australia.

ADS-B in Non-IFR Aircraft

- Transmitted signal must be compliant.
  - Installation must meet all requirements.
- SIL = 2 or 3 will enable ADS-B based separation.
  - SIL = 0 or 1 can only be used for traffic advisory purposes.

CASA ADS-B ISSUES

- Timing – ahead of FAA 2020
- Regulation Updates
  - Perth Mandate
- Airframe manufacturers
  - Type Certificate
  - Boeing 787 incorrect position
- Some fitments not tested correctly
- General Aviation Avionics
  - Finally some cheaper GA ADS-B – but not nav capable
- Lack of adequate training material

Mode S Transponder Mandates

- From 6 February 2014:
  - Aircraft registered or modified on or after this date must be equipped with a TSO C112 ADS-B capable Mode S transponder if the aircraft is operated in:
    - Class A, B, C or E airspace; or
    - Above 10,000 feet in Class G airspace.
  - Aircraft are exempt if they do not have an engine or sufficient electrical power to operate a transponder if the aircraft:
    - Operates in Class E airspace; or
    - Above 10,000 feet in Class G airspace.
  - Aircraft operating at Brisbane, Sydney Melbourne or Perth aerodromes must be equipped with an ADS-B capable transponder.
  - The modified aircraft requirement is applicable to new or replacement installations, not repair of existing installations.

Equipage Rates

- Airservices flight plan analysis shows:
  - 98.5% of flights are GNSS equipped.
- ADS-B Equipage:
  - Above FL 285:

    Airlines 99.5% Bizjets 89% Turbo Prop 98%
  - Helicopters 42%
  - All IFR 74%
- There is no case to defer the final mandate!

26 MAY 2016

- AIRAC PBN Implementation Date
- RNP 2 in domestic airspace – enroute
- RNP 1 in terminal areas (30 nm)
- RNP 2 based air routes – gradual role out
  - Revised routes and safety heights
- Removal of some 180 navigation aids
- Use of RNP based separation

Implementation Issues

- Transition planning.
- ICAO transition guidance.
- NAA capability to issue navigation authorisations.
- Stakeholder communications.
- Flight Planning – no RNP 2 in 2012 Flight Plan
- Regulator business systems.
- Errors in aircraft equipment
  - GNSS
  - ADS-B – wrong codes, incorrect position

Transition Planning

- Creating the PBN rules and guidance material is about 20% of the implementation task.
  - Requires a diverse team of technical specialists.
- Training is a major problem:
  - Flight crew training is covered in the PBN Manual.
  - All personnel from managers, operations support, dispatch and maintenance all require training.
- Operators did not plan to meet the mandates early:
  - Monitoring compliance and engaging with non-compliant operators is essential.

ICAO Transition Guidance

- ICAO needs to develop global transition plans:
  - The difficult part of implementation from the old to the new environment.
  - Legacy navigation specifications need to be withdrawn from service to reduce the number of standards in use.
    - Reducing the number of navigation specifications simplifies the navigation authorisations environment.
    - Australia has adopted RNP 2, RNP 1 and RNP APCH–LNAV as the national standards.
- ICAO recommended to address global transition planning guidance.

NAA Ability to Issue Authorisations

- All States need to have the ability to issue authorisations for all navigation specifications.
  - States not able to issue authorisations to their operators will impede the operator's ability to operate in foreign States.

Stakeholder Communications

- Stakeholder communications during the transition process is the largest and most consistent part of the implementation project.
- Multi-media general and targeted communications are needed:
  - Brochures, magazine advertisements, email, Facebook, Twitter, websites, AIC should all be used.

Regulator Business Systems

- Regulator business systems for managing navigation authorisations need to be simple and efficient:
  - Regulatory ‘red tape’ is a serious burden on industry.
  - Inefficient processes create undue burden on industry and the regulator alike.


australia
photo: michalturski.com

Ian Mallett

Section Head CNS

CNS/ATM

CASA Central Office Canberra

ph: +61 2 6217 1736

+61 418259626

e-mail: ian.mallett@casa.gov.au

https://www.casa.gov.au/regulations-and-policy/standard-page/cns-atm

Questions?


Photo Copyright Mark Garfinkel
AIRLINERS.NET

US versus Australia Demographics

Item	United States	Australia	Comments
Land area	2,954,842 sq miles 7,653,006 sq km	2,988,901 sq miles 7,741,220 sq km	Australia = 1.2% larger than the lower 48 US states
Population	322 million	23,979,000	Australia = 7.5% US
Aircraft Fleet	205,000	15,000	Australia = 7.3% US
Radio NAVAIDs	1000's	415	181 decommissioned 26 May 2016
Surveillance radars	c480	23	
Airports (paved / unpaved)	5,194/9,885	326/139/304	2010 data
GPS Approaches / airports	3,712/1,856	625/304	Jan 2016 data

GNSS Interference

- GPS performance is 3 times better than specification.
  - Solar events are becoming predictable.
- Interference will be geographically and time limited.
- Probability of loss of function for a single TSO C146 GNSS is less than that for ADF/NDB – the standard for the last 70 years.
  - NDB loss of SiS = 3×10^{-4} per hour
  - GNSS loss of SiS = 9×10^{-9} per hour
  - $LoF_{ADF/NDB}$ = 9×10^{-4} for 2 hour flight and 2 hour alternate. ($<1 \times 10^{-3}$ required)
  - LOF_{GNSS} = 4.5×10^{-4} for 2 hour flight and 2 hour alternate.

GNSS Interference

- Terrestrial interference is the greatest threat:
  - Interference will be geographically and time limited.
  - BNN is intended to provide an alternate means of navigation for TSO C129 equipped aircraft.
  - BNN is not intended to support normal operations.
    - BNN will support limited operations only.
- 99% of GPS interference problems originate from causes within the same aircraft.
- Possession of a jamming device is an offence!
  - Jamming devices are prohibited imports.

GNSS Interference Mitigation

- Most aircraft carry an alternate means of navigation.
- Alternate means of navigation:
  - Inertial to ILS
  - VOR
  - ADF/NDB
  - Radar vectoring
  - Dead reckoning
- CASA specifies the minimum standard.
  - Operators should consider ‘Plan B’ for their operation.
    - SMS is applicable.