UPDATE On GNSS Aviation Operations In Australia
GPS

- Excellent and improving service
  - Thank you USAF!!!
- Since 1995 no system issues
  - Primary Means GPS in 1995
- Issues
  - SPS – please update to real performance!
  - Some minor NANU Errors
    - Leads to RAIM prediction errors
- Some States still have concerns with GPS
  - Lack of Knowledge of ICAO (GPS) Status
    - More education needed
BASIC GNSS OFFERS MANY BENEFITS

- Standards in Place
- Cheap and simple
- Disaster immune
- Little Implementation in Region
- Why?
Very high user expectations due to excellent performance
Reduction to SPS level would totally undermine user confidence
GPS Constellation Management Critical
Background

- Early decision – 1991
  - Lack of ground based infrastructure
  - Move to user pays funded system
    - No Government support other than for regulation
- Acceptance of US TSO C129 receiver
- Move to GNSS navigation
  - 85% of all operations now use GPS
  - Approvals range from NVFR to RNP-AR
HISTORY 2

- ICAO GNSS Panel formed in 1994
  - ICAO Circular 267
  - Basis for ICAO GNSS Manual in 2003
- 2003 Navigation Systems Panel
- 2003 ANC -11 = GNSS Transition OK
- ICAO GNSS Manual - Doc 9849
- Doc 8071 – Flight Inspection & Validation
- PBN Manual in 2007
GNSS Receivers
FIRST IFR GPS RECEIVER

Still 10,000+ in operation
TSO C146 Receivers

Includes VHF, VHF NAV and GPS

Garmin Simulators - free download
TSO C145/6

- Fault Detection and Exclusion (FDE)
- Selective Availability OFF
- Advanced RAIM
- Better Interference Protection
- Better Human Factors
- SBAS Capable (but not required)
- Available Training Aids (CD)
- Primary Means Design
RECEIVER DESIGNS

- ICAO – new approvals should be C145/6 based
- MMRs – multi mode receivers
  - Now the GNSS Sensor in Modern Airliners
    - IATA – “No SBAS in our aircraft”
      - WHY??!!
- Galileo/GPS Hybrid Receivers expected
NEW AIRCRAFT

- TSO C146 Receivers
  - GPS
  - VOR
  - ILS
- Not fitted with ADF
  - Includes airlines aircraft
- RNAV “primary means’ approval
  - Needs the RPS for planning
GNSS Approvals

- Primary Means Domestic Enroute – 1995
- GPS Arrivals - 1995
- GPS Oceanic - 1998
- GPS Non Precision Approaches – 1998
- GPS in Lieu of DME
- GPS Separation Standards
- GPS Safety Heights
- FANS B747, Most Airline Aircraft (Defence??!!)
GNSS APPROVALS (2)

- RNP 0.1 NM into Queenstown
  - B737-800
    - 35 extra passengers
    - Guided departures

- ADS-B 2006
  - 5 NM Separation Standard Approved

- Primary Means with TSO C145/6 receiver
  - Equivalent to VOR or NDB

- RAIM Predictions Systems
  - 1998 Airservices Australia system – Volpe US DoT
  - 2006 – with C145/6 and FDE
GPS ENROUTE

- Approved in 1995
  - Primary Means
  - Single TSO C129 Receiver
    - With Baro-Aiding
  - Domestic FIR
  - 1% immediate fuel saving
  - Used by practically all IFR operators
- 12 NM separation standard
  - 10 minutes of non RAIM ops allowed
  - No Enroute Prediction Required
- RNAV routes using GPS
- Savings around $50 mil per year in 1996
- No reported interference in 12 years
- No Reported RAIM losses
RNAV (GNSS) APPROACHES

Approved in 1998
Aerodromes with GPS/NPA

272 Aerodromes

500+ GPS approaches
GPS APPROACHES

- ICAO Pans Ops
  - Based on US TERPS
- Approved in 1998
  - 500+ approaches
  - Used by GA and airlines
    - Boeing 737, A320, A330
  - “25” times safer than circling NPA
- RAIM prediction system on web site
- GPS Training Material – videos, slides etc
RAIM PREDICTION

- Available on Airservices Web Site
  - [www.airservicesaustralia.com](http://www.airservicesaustralia.com)
  - Supplied to other countries
- Is a NOTAM
- Uses GPS Receiver plus Status Messages
- More accurate than receiver
- Two types
  - C129 and C145/6 with FDE
  - Also oceanic prediction
- Highlighted **errors** in Status Messages
YSCB

TSO-C129(a) (and equivalent) Fault Detection

0703100409 TIL 0703100419
0703110405 TIL 0703110415

GPS RAIM FD Unavbl for NPA TSO-C146a (and equivalent) Fault Detection Only

No GPS RAIM FD Outages for NPA TSO-C146a (and equivalent) Fault Detection and Exclusion

0703090749 TIL 0703090756
0703090824 TIL 0703090834
0703100409 TIL 0703100426
0703100438 TIL 0703100458
0703100741 TIL 0703100809
0703100816 TIL 0703100830
0703101609 TIL 0703101618
0703101625 TIL 0703101632
0703110405 TIL 0703110422
0703110434 TIL 0703110454

GPS RAIM FDE Unavbl for NPA
INTERFERENCE

- No reported IFR interference
- Installation Interference
  - 99%+ of all reported
- TSO C145/6 receivers far better in testing
- DoD Trials
  - Need to be closely managed and monitored
- Jammers banned in Australia
- Strong Frequency Protection – ACA
- Will need isolation in busy environment
ACCIDENTS

Three “RNAV (GNSS) Accidents”
- Reports on www.atsb.gov.au
- Two were ‘piloting’ errors
- One unresolved – 11km offset in position
  - Possible Antenna Error???

ATSB Survey of Pilot Attitudes to RNAV (GNSS)
- Waypoint naming
- Level of difficulty ‘second to NDB’
  - Orientation, Step Down Fixes, Receiver Use
- Value of APV Approaches
SUMMARY

- WGS-84 Essential
- Basic GNSS provides high returns
  - Enroute RNAV
  - RNAV (GNSS) Approaches
- APV is ICAO preference
  - RNP APV is available now!
- Ensure ICAO RNP Manual is used
- New Approvals Should be based on TSO C145/6
- RNP +ADS-B = Airspace Heaven!!!
RNP BENEFITS

- **Safety**
  - Runway aligned DA – almost anywhere
  - Lateral & vertical guided approaches
  - CFIT risks reduced
  - Use of automatics
  - Engine INOP solutions

- **Operations**
  - Departure uplift +35 additional passengers!
  - Significantly Lower Minima (-1100’)
  - Great cost benefit outcome

- **Efficiency** – saves some 2-300 kg fuel per flight

- **Environment** – reduced noise footprint
The area under the fog is Lake Wakatipu, which after the fog cleared looks like this.
Sydney GLS
GLS STATUS

- FAA have reverted to “R&D” status
  - Due design issues
  - FAA certification “early 2009”
- Aircraft OEMs – GLS Receivers certified
  - B737-800, A380 etc
  - No certified ground systems
- Qantas/Sydney GPS installation
A380 USED GLS INTO SYDNEY
ADS-B in Australia
Radar Like Application

“ADS-B OUT”

Typically broadcast 1/second

POSITION, ALTITUDE, IDENTITY(CALLSIGN), VELOCITY VECTOR, VERTICAL RATE

ADS-B Ground station
UPPER AIRSPACE PROJECT

28 ground stations are being deployed at existing communications sites throughout outback Australia

...expanding high level automatic air traffic surveillance capability from less than 20% of the Australian continent to over 99%.
ATLAS PROJECT

- Mandate ADS-B carriage
  - EOY 2013
  - Funding provided for GA installation

- Main benefits
  - Adoption of GNSS RNAV
  - No Replacement on enroute SSR Radars

- Nav Aid Rationalisation Program
  - Reduction in ADFs and VORs
APPROACHES WITH VERTICAL GUIDANCE

APV
ICAO APV DECISION

- ICAO CFIT Study – now Required
- Up to 8 times safer than circling NPA
- Vertical Guidance is the Key!!
- ICAO 100% APV by 2016
- Adopted by APANPIRG in Regional Plan
- Booz Cost/Benefit Study
  - Baro-VNAV APV First
APV TECHNOLOGIES

- **Baro-VNAV RNP** B738-800
- **Augmented GNSS**
  - SBAS (US WAAS – 900 LPVs)
    - Now approved to 200'/1/2 NM visibility
    - Japanese MSAS will be operational in IQ/2007
      - Visible in Australia
  - GBAS
    - GLS in Sydney – certification in early 2009
  - GRAS
    - Development now on hold
- **Combined Systems**
  - GPS + Galileo
ELECTRONIC AIS

- 1 bit of data in 1000 is WRONG!
  - EC Study
  - Unsuitable for RNP 2
  - State Data have large errors
  - Third party providers doing quality control

- Major issue with RNP Approaches
  - Needed additional integrity measures to make it work safely

- Electronic Flight Bag (EFB) etc now here

- Data Integration – eg Terrain and AIP
  - eTOD ICAO requirements
  - Large terrain errors – 2000’++

- Solution = Single Electronic System
  - AIXM as ICAO Standard = EAIP

- Government – “Regulate AIS”

- Current data base is required for IFR
OUTCOME

- APAC Region moving to a satellite-based infrastructure
  - Enroute
  - RNAV (GNSS) Approaches
  - Baro-VNAV Approaches
  - RNP-AR

- PBN Based System
- Wide variation in Implementation

- Safety – Efficiency - Environment
GNSS ADOPTION

Most people unaware of GPS use
  – Timing, finance, agriculture

Quite revolution!

Complete acceptance

Car navigators have saved many relationships!!
AUSTRALIAN WEBSITES

- www.airservicesaustralia.com
  - Publications, RAIM
  - prediction, ADS-B Program
- www.casa.gov.au
  - GPS approvals
- www.astra.aero
Good Bye

- Airservices GRAS Project cancelled
- GLS going ahead
  - Approval by FAA in early 2009

- Keith McPherson sends his regards
  - Pursuing new goals
  - Contact details available
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QUESTIONS & DISCUSSION