GNSS and PBN

Ian Mallett Luke Gumley

AIM

- To examine GPS

- Transition to space-based CNS

- Review the role of GNSS in PBN

- Identify issues in implementation of PBN

- Work for PBN Task Force

- **Promote discussion** ➡ **Resolution**

STRUCTURE

Peter Cromarty

Airways and Aerodromes

Airspace

Aerodromes & CNS/ATM
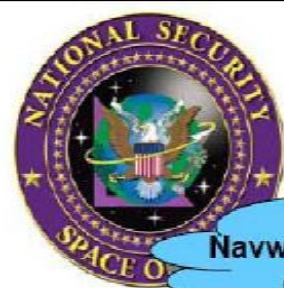
Airways

Airspace Change

Operations

Military

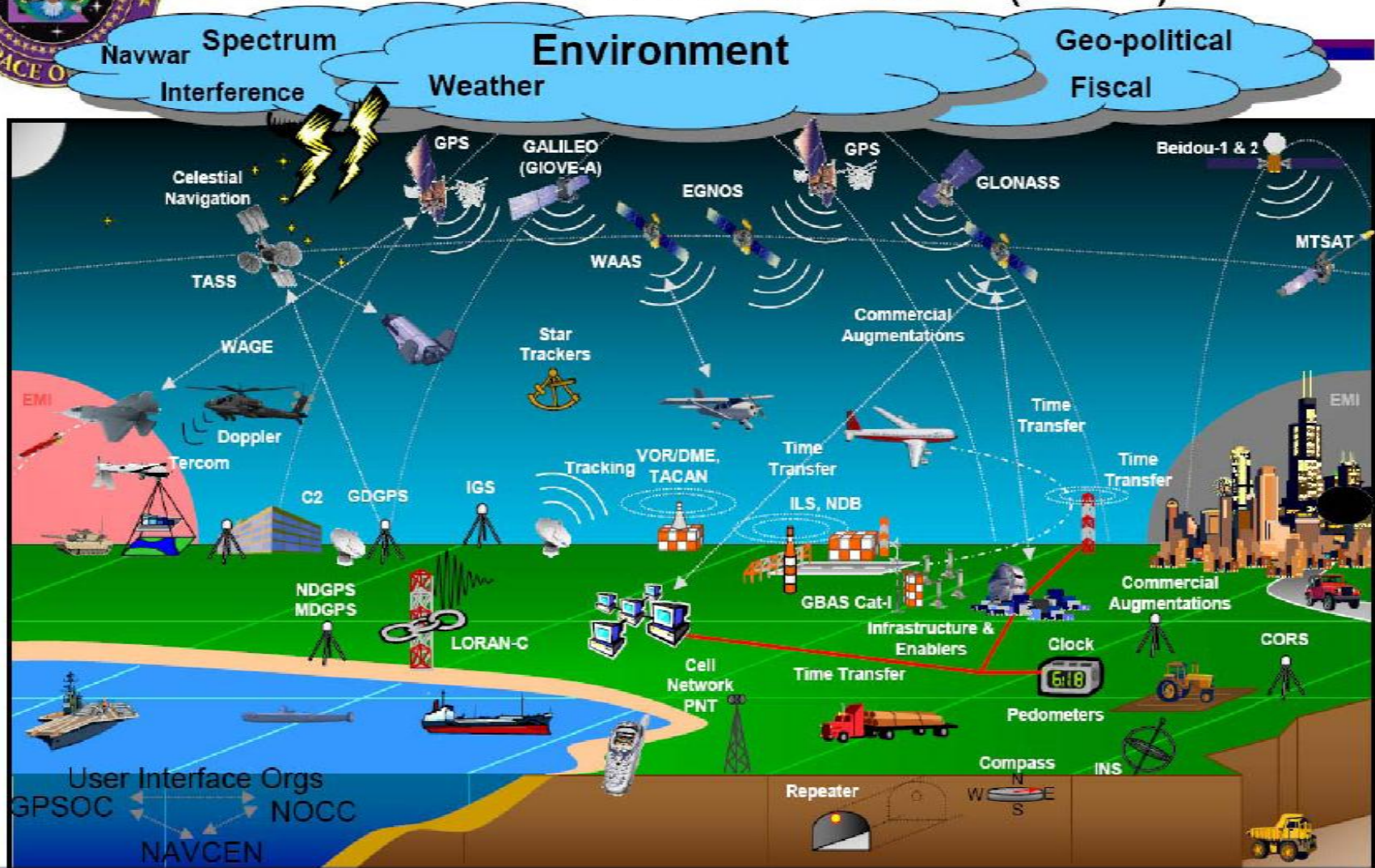# AIRWAYS AND AERODROMES

- Regulatory Parts – Standards and Compliance
    - Part 139   Aerodromes
    - Part 139H   Rescue and Fire Fighting
    - Part 171   Telecommunications & Radio Navigation
    - Part 172   Air Traffic Services
    - Part 173   Instrument Approach Design
    - (Part 174)   Meteorology
    - (Part 175)   AIS + AIP

- All have their associated ICAO Panels and Working Groups

ICAO POSITION

- Transition to satellite based CNS/ATM
  - ANC/11 in 2003
    - Vulnerability Study by Nav Panel
- GNSS systems accepted for civil aviation use
  - GPS WAAS EGNOS
  - GLONASS

Draft "As-Is" PNT Architecture (2007)

ICAO

- Navigation System Panel (NSP)
    - Annex 10 – ongoing changes
        - Chinese GNSS System to be SARP'ed
    - Revised GNSS Manual
    - PBN Study Group – Revised PBN Manual
- Safety and Separation Panel (SASP)
- Instrument Flight Procedures Panel (IFPP)
- Operations Panel, Safety Management Panel
    - Oversight of other panels?
- Many Task Forces and Study Groups
    - PBN "Tiger Team" and PBN Study Group

ANConf/12 – Nov 2012

- Air Navigation Conference - Nov 2012
  - One every 10 years
    - Sets way ahead for ICAO
- ASBUs!
  - Aviation System Block Upgrades
  - Blocks 0 -5 To be agreed at ANConf/12
  - Australian/Regional Position?
- Change to ICAO processes?

ICAO REGIONAL

- PBN Task Force – Bangkok
- Seamless ATM Task Force
- Asia Pacific Regional Safety Team + RASG
- APANPIRG and sub-groups
- ICAO Flight Procedures Office – China
- (APEC GNSS Implementation Team)
- Sat Com (Voice) Task Force (SCV)

GPS REVIEW

- Operation since 1990s for civil use
- Excellent performance
- US ICAO commitment – GPS and WAAS
- Continued improvement
  - Accuracy and availability
- Upgrades in progress
- Second civil frequency
  - Reduces ionospheric error
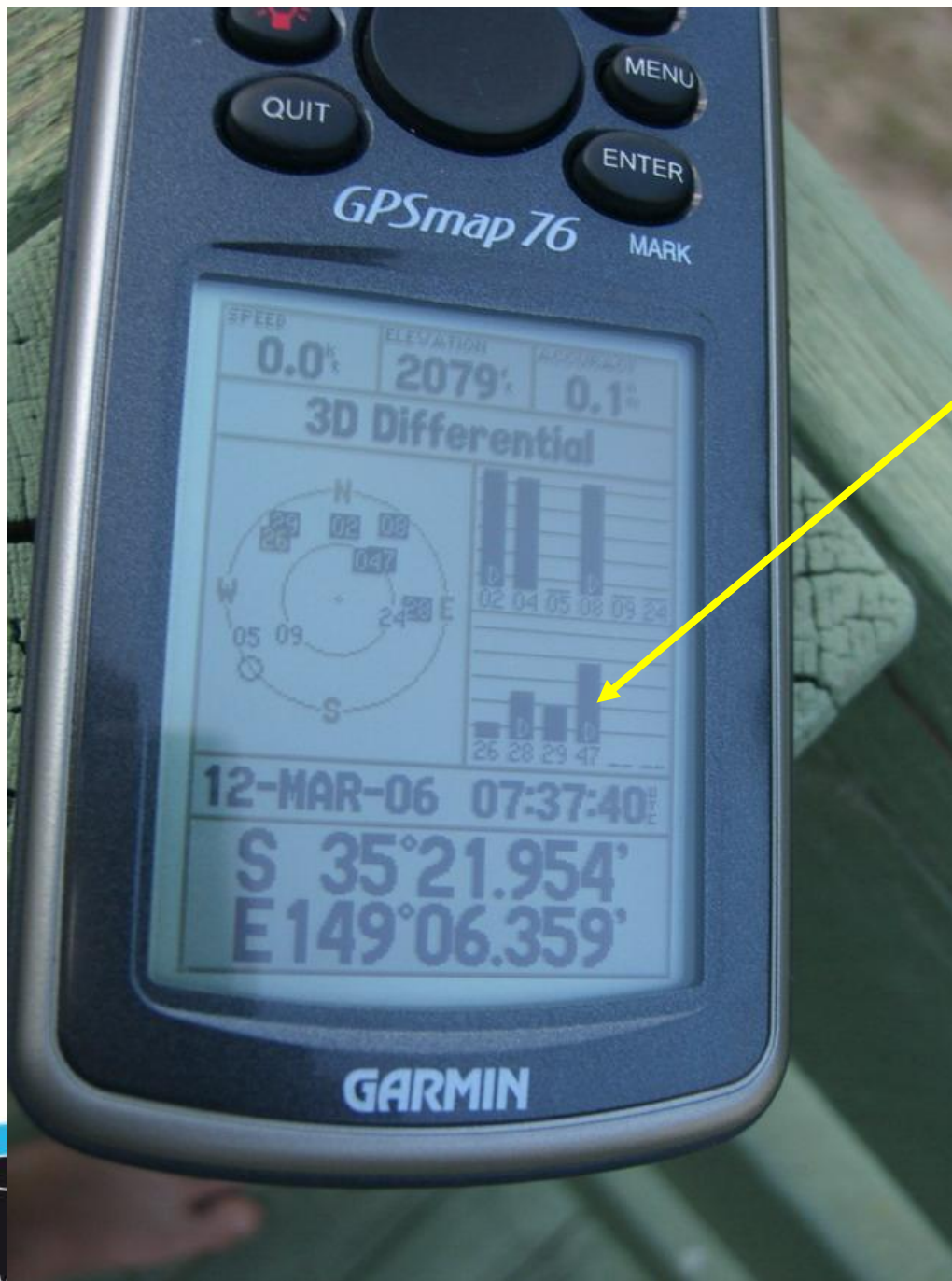- GPS III

AUGMENTATIONS

- **AIRCRAFT BASED - ABAS**
  - INS/GPS, AIME, RAIM

- **SATELLITE BASED - SBAS**
  - WAAS (June 2003), EGNOS
    - MSAS GAGAN
  - GPS + GLONASS (or GALILEO)
  - Regional augmentation

- **GROUND BASED - GBAS, (GRAS)**
  - Precision Approach – ILS,MLS
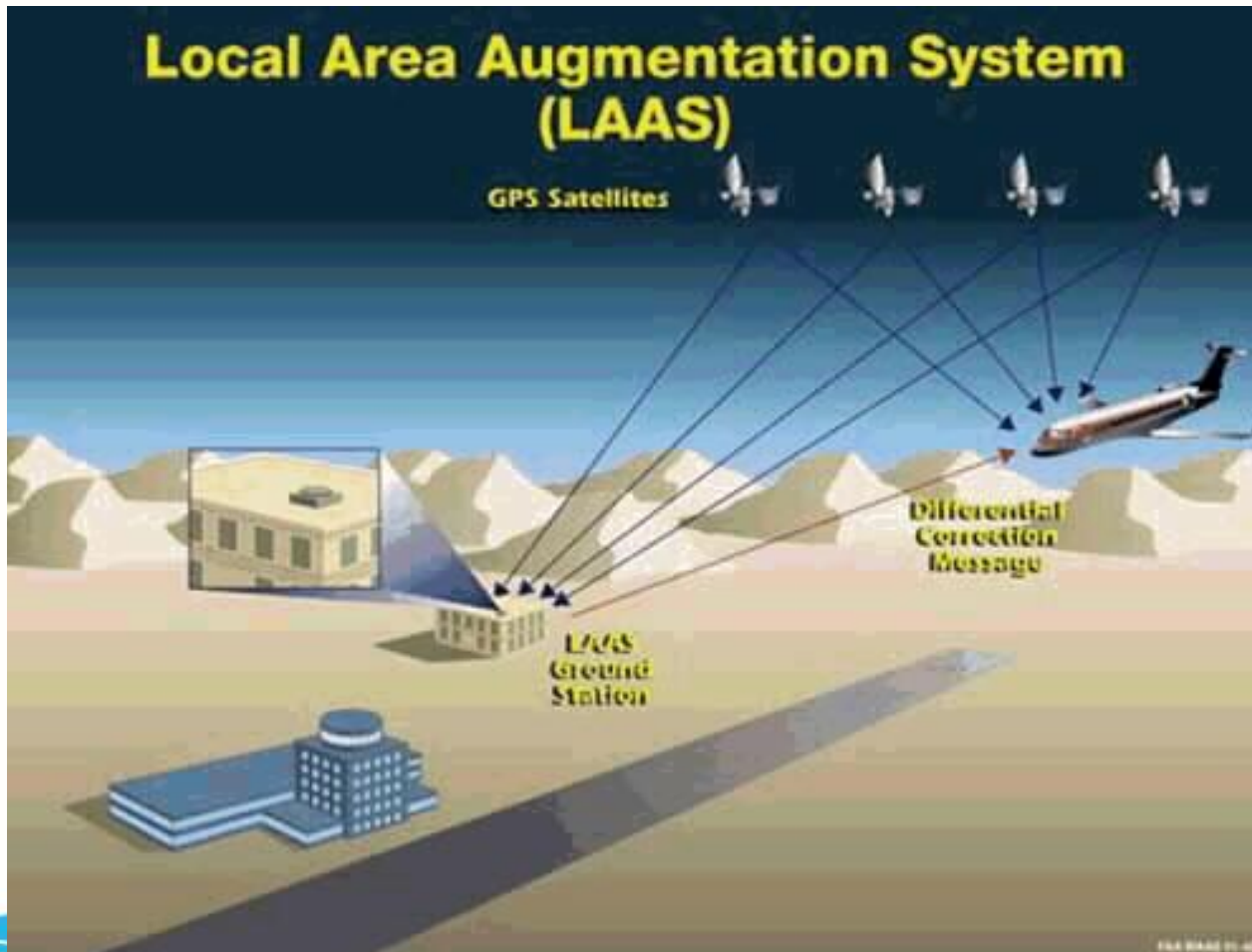   - GLS – Sydney B737 and A380

What is SBAS?
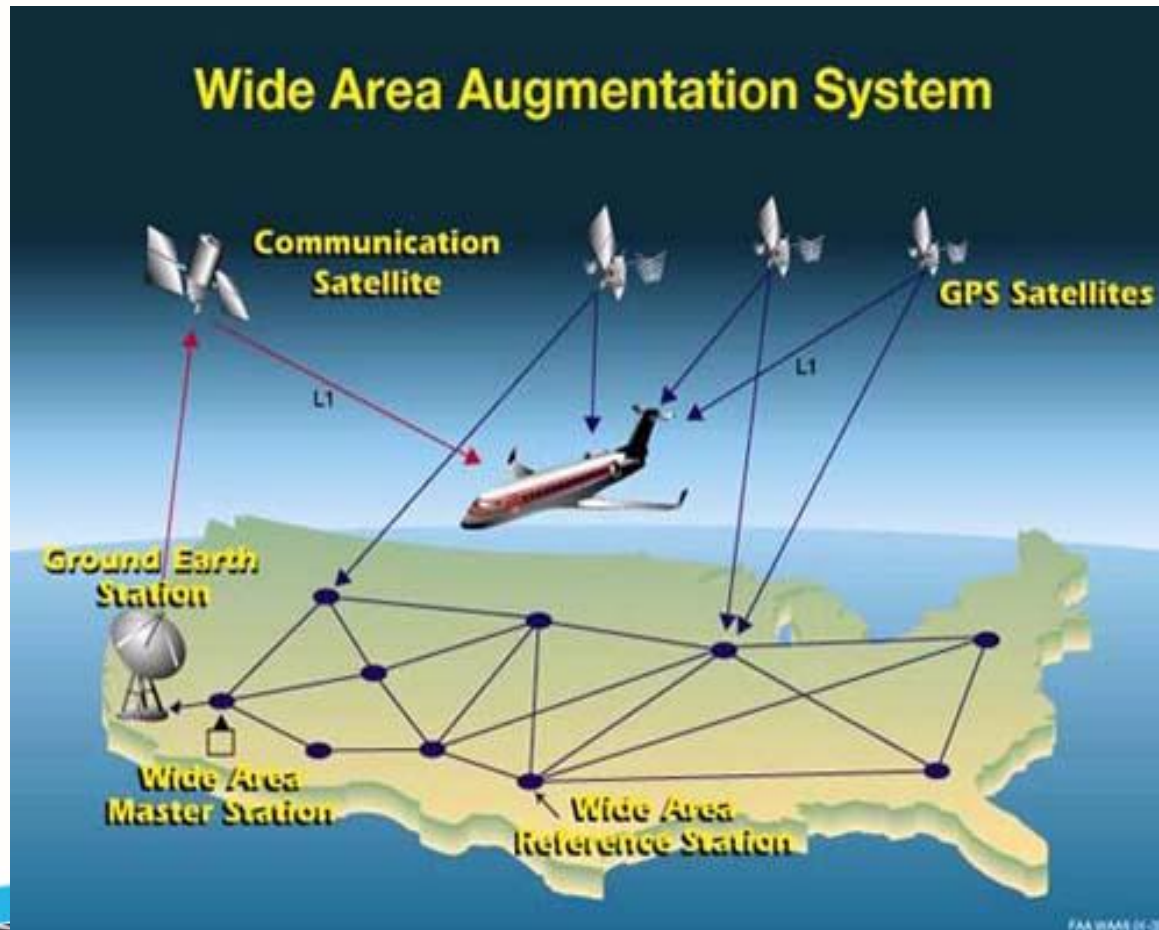
WAAS

What is GBAS

SYDNEY GLS

A380 GLS INTO SYDNEY

GLS SYDNEY

- Honeywell GPS 4000 in place
  - All six runways at Sydney
  - Charts available AIP Sup
- Part 171 certification expected in Jun 2012
- Operational Use?
- Operator approval
  - Overseas approval
    - State regulator or by Australia?

NEW AIRCRAFT

- TSO C146 Receivers
  - GPS
  - VOR
  - ILS
- **Not fitted with ADF or DME**
  - **Many airline aircraft**
- RNAV "primary means' approval
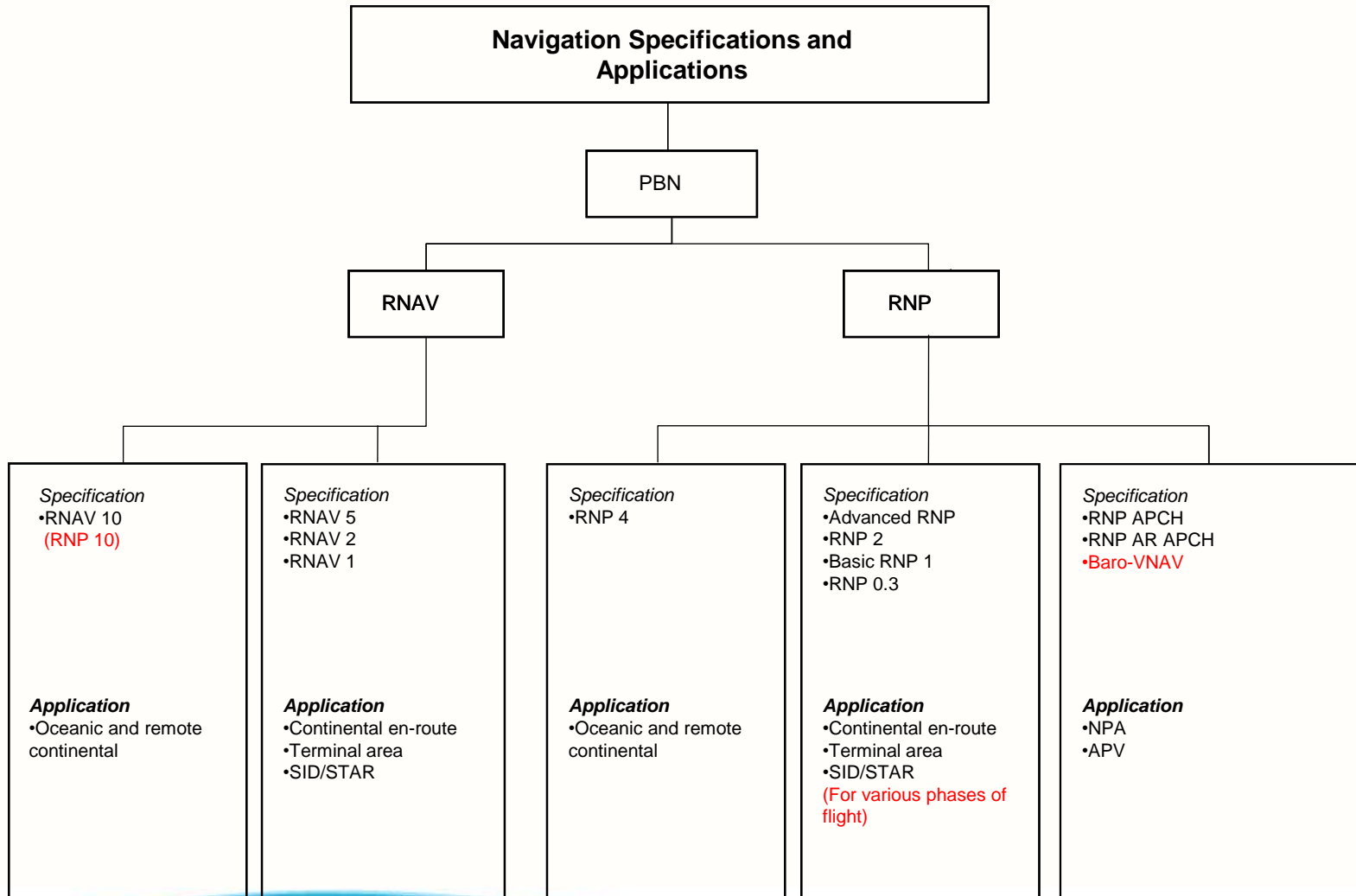 - Only aid required

GNSS APPROVALS

TSO C129

- Fault Detection Only
- "old" MOPS
  - 1993
- No guarantee of MOPS inclusion

- OK with IRS on CASA approval

TSO C145/6

- FD and FD Exclusion
- Better Human Factors
- Better displays
- Easier Approach Selection
- New Antennae – C144
  - 1000 better I/F protection
- New processor
- Primary Means Approval

PBN NAVIGATION

```
┌─────────────────────────────────┐
│   Navigation Specifications and  │
│          Applications            │
└─────────────────────────────────┘
                 │
            ┌─────────┐
            │   PBN   │
            └─────────┘
           ┌──────┴──────┐
      ┌─────────┐   ┌─────────┐
      │  RNAV   │   │   RNP   │
      └─────────┘   └─────────┘
```

Specification	*Specification*	*Specification*	*Specification*	*Specification*
•RNAV 10 (RNP 10)	•RNAV 5 •RNAV 2 •RNAV 1	•RNP 4	•Advanced RNP •RNP 2 •Basic RNP 1 •RNP 0.3	•RNP APCH •RNP AR APCH •Baro-VNAV
Application •Oceanic and remote continental	***Application*** •Continental en-route •Terminal area •SID/STAR	***Application*** •Oceanic and remote continental	***Application*** •Continental en-route •Terminal area •SID/STAR (For various phases of flight)	***Application*** •NPA •APV

PBN at Work

RNP
Arrival/Approach

ILS
Arrival/Approach

Runway

Brisbane
City
Centre

High Noise

Medium Noise

Low Noise

Noise vs Carbon?
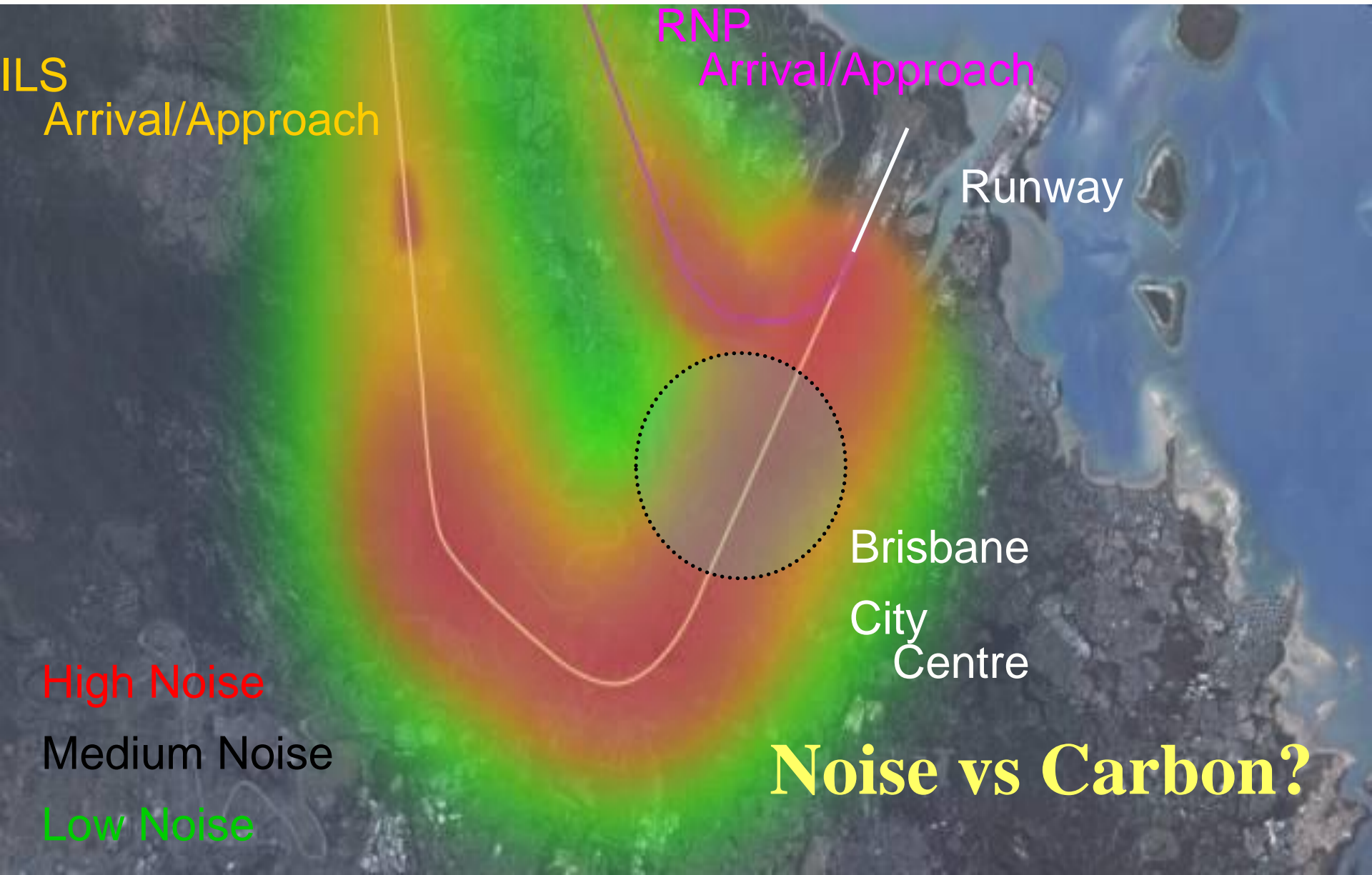
NEW GNSS SYSTEMS

- GPS 3
  - Upgraded satellites
    - Dual frequency
- GLONASS
  - Being upgraded
- GALILEO
  - 2014+
- COMPASS
  - 2012!
- Result = hybrid receivers
  - Design and certification ➡ Fleet Fitment????

GPS ISSUES

- Governance and Sustainability
  - US NAO report
    - Reduced number of satellites?
- Interference
  - Solar – high sun cycle
  - Man Made
    - Unintentional and deliberated
- Frequency Protection
  - LightSquared
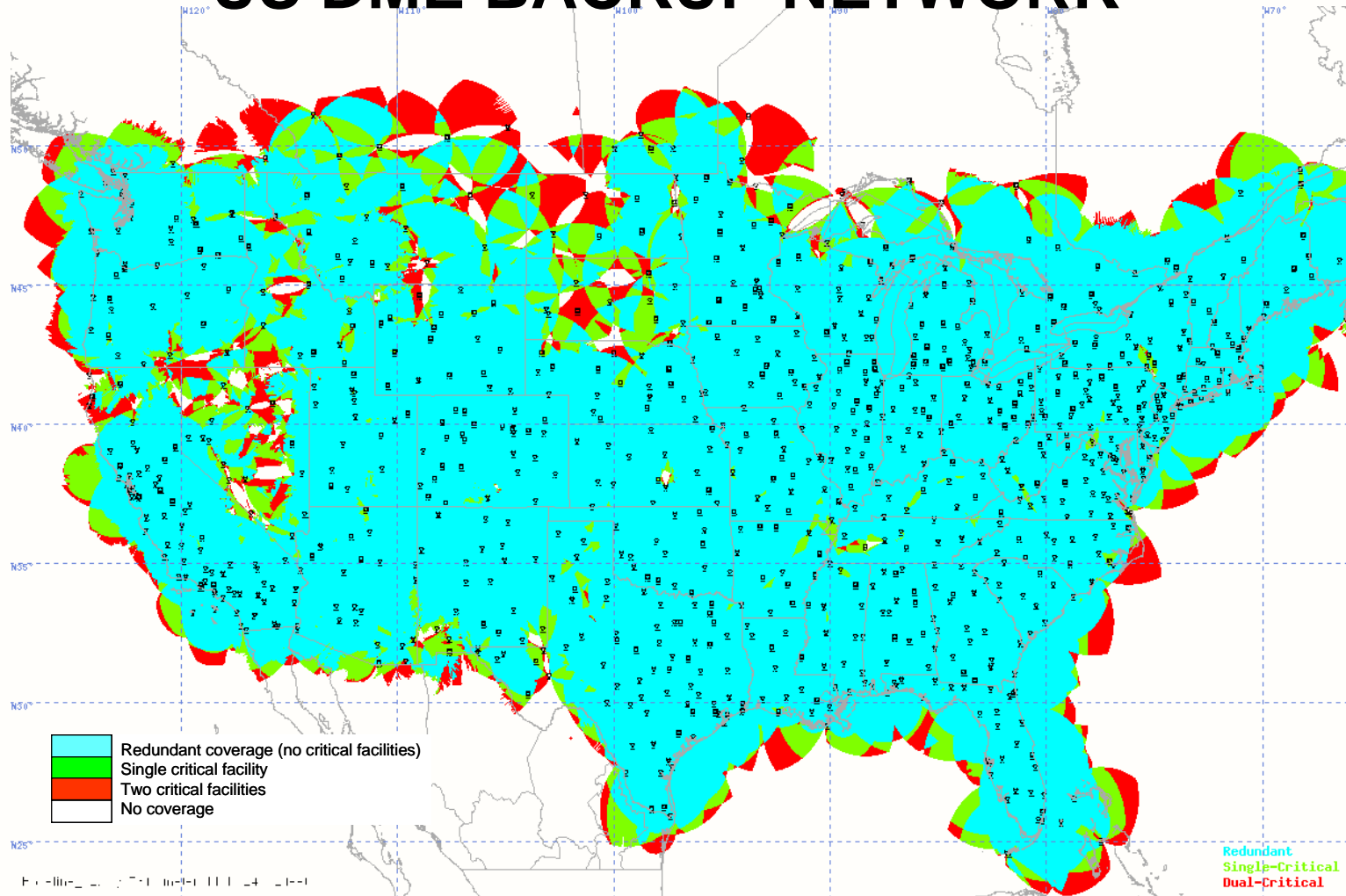
PERSONAL PROTECTION DEVICE

Need regulations to prevent use

ROYAL ACADEMY PAPER

- **Global Navigation Space Systems:**
  - **reliance and vulnerabilities**
- Recommendations:
  - Raising awareness and analysing impact
  - Review the dependencies (direct and indirect) on GNSS and mitigate the risks
  - Contingency plans for GNSS outages

US DME BACKUP NETWORK

Legend:
- Redundant coverage (no critical facilities)
- Single critical facility
- Two critical facilities
- No coverage

Redundant
Single-Critical
Dual-Critical

CIVIL AVIATION SAFETY AUTHORITY

REGIONAL ISSUES

- Many States don't have PBN Plan
- Lack of State GNSS and PBN Rules
- Shortage of Instrument Approach Designers
- Need for a sub-regional PBN groups?
  - Eg SW Pacific
- Implementation of PBN air routes?
- Is there a back-up to GNSS in APAC region?
  - Is it needed?

RAIM PREDICTIONS

- Basic receiver predictions
    - Integrity (Fault detection)
    - Exclusion (FDE)
- RNP Predictions for Enroute/Approach
    - Use software that matches aircraft
    - Don't use aircraft prediction system
        - Need ground system to allow NANU/GPS input
        - Mask Angles
        - Aircraft specific algorithms.

DME/GPS SUBSTITUTION

- Approved by ICAO

- DMEs are not in GPS data base

- Need to ensure correct waypoint used
  - Should be noted on approach chart

- Beware of ILS and specific DME
  - Could use new 5 letter waypoint
  - Publish on chart

ICAO APV RESOLUTION

- Remove circling approaches
    - 25 times less safe than straight in
- All approaches with vertical guidance by 2016
    - 8 times safer again
- Without SBAS the only option is
    - Baro-VNAV
        - GNSS Baro-VNAV
        - RNP (AR)
    - Most GA aircraft are incapable of Baro-VNAV

APPROACH CLASSIFICATIONS

- **Non Precision**
  - NDB, VOR, RNAV (GNSS)
  - LLZ

- **APV**   (Definition being reviewed by ACTF)
  - SBAS – LPV
  - Baro-VNAV
    - RNP-AR

    No associated lighting and runway standards

- **Precision**
  - ILS, MLS, GLS

BARO-VNAV APPROACHES

- Only run aligned approaches
  - Cannot offset – RNAV (GNSS) up to 15 degrees
- Missed approach point at runway
- Use of "W" design surface
  - Intended for SBAS approaches

VERTICAL GUIDANCE

- Advisory vertical "guidance" vs true vertical guidance??

- Significant level of miss understanding
  - Numerous near accidents in RPT aircraft
    - 400' below "hard' NPA altitudes

- Manufacturers selling 'vertical guidance'
  - Lack of appreciation of issues
  - Equipment not capable of Baro-VNAV

- True vertical requires equipment, approach design, data base, crew qualification, accurate baro input

OVERLAY APPROACHES

- Use of GPS (RNP) to fly NPA approaches

- Approved for specific approaches by US

- Some NPA approaches cannot be flown by basic GPS receivers (Australian NPAs)

- RNP overlay of NPAs

  - Should be in Flight Manual and data base

  - Does not include LLZ approaches

  - Requires specific approval

- Include use of aid on flight plan

ICAO PBN TIGER TEAM

- Set up to review PBN material

- Produce ICAO PBN Advisory Circular

- Develop

  - PBN Ops Approval Manual

  - PBN E-Learning courses

- Next meeting 26-28 June 2012

WHERE TO START WITH PBN?

- Basic RNAV (GNSS) approaches
    - Many aircraft are in fact are flying RNP not GNSS!
- Airspace Review
    - PBN based airspace and air-routes
- ICAO RNP procedures
    - Departure and Engine out?
- RNP-AR pressure to implement
    - Are aircraft specific
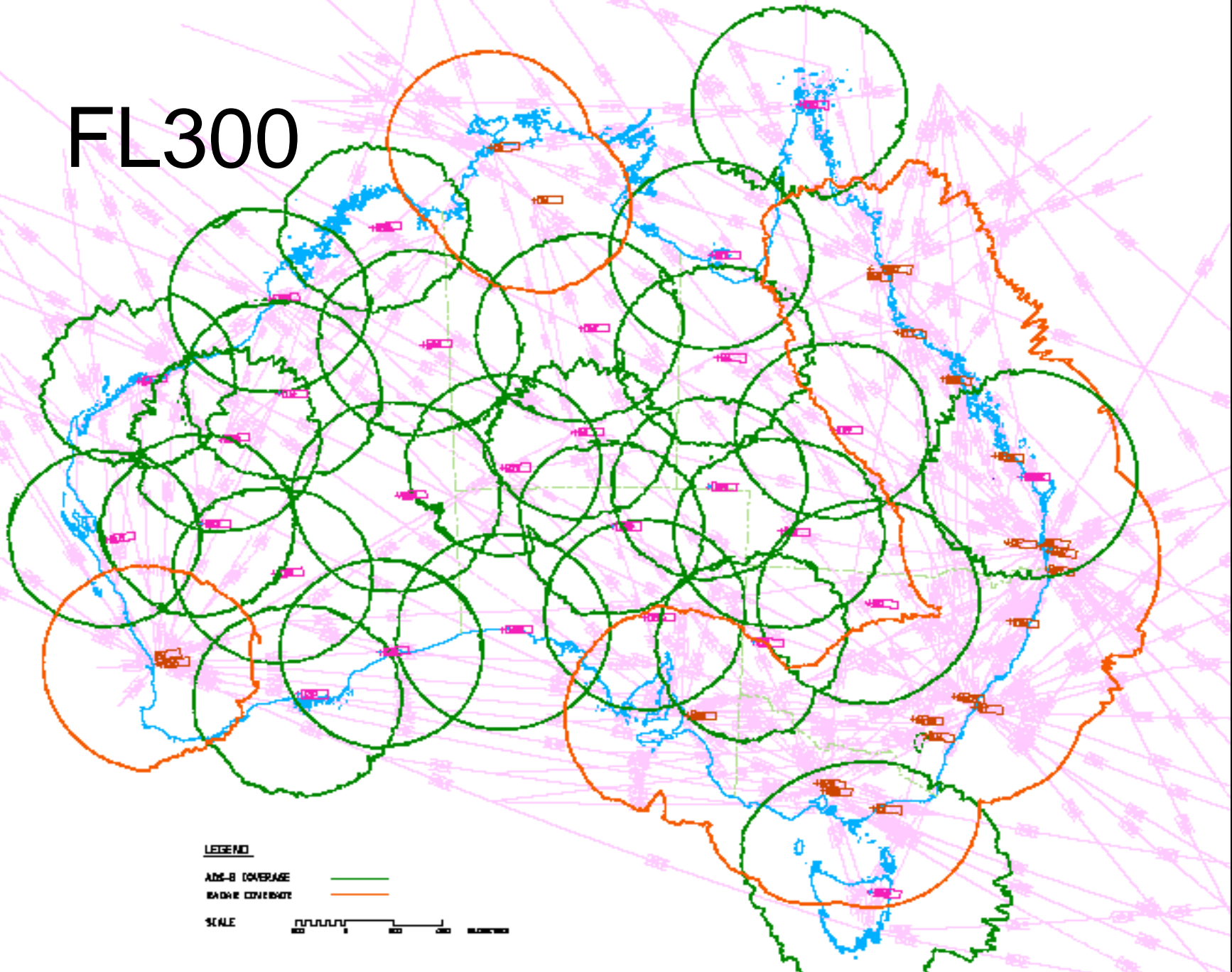   - Require training and adherence to procedures

TRAINING

- ICAO GNSS Manual

- ICAO PBN Manual

- Course available include
  - Singapore Aviation Academy
  - FFPO Approach Design Courses
  - COSCAP PBN
  - ICAO "GO" Team training

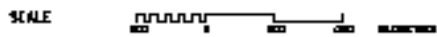- Much PBN training is focused on RNP-AR

ADS-B in Australia

CIVIL AVIATION SAFETY AUTHORITY
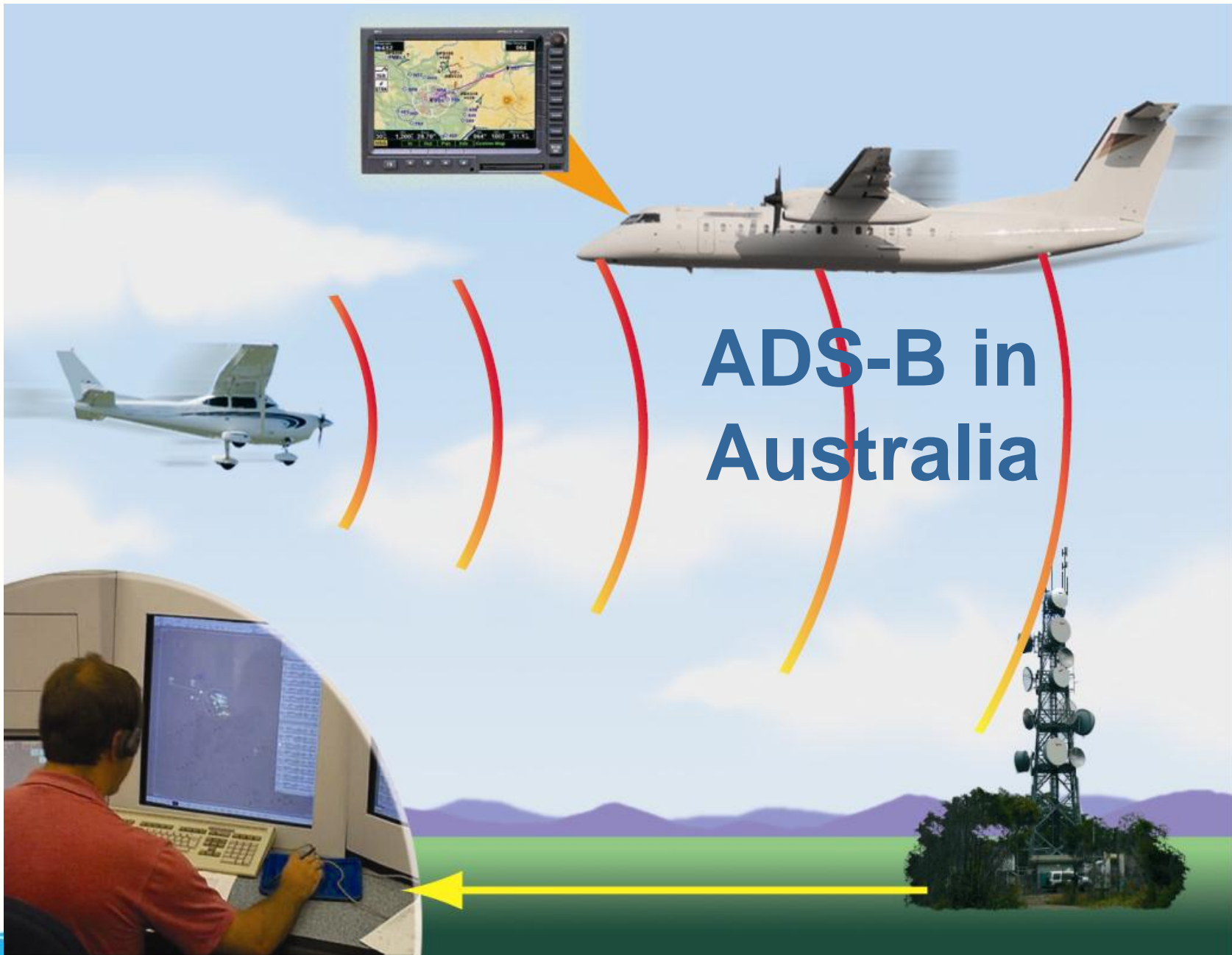
FL300

LEGEND

ADS-B COVERAGE
RADAR COVERAGE

SCALE

Sat Com (Voice)

- ICAO Decision in mid 1990s – no SCV
  - English Language
  - Move to CPDLC
    - Reduced separation such as 30/30
  - Cost
- Airservices not set up to do SCV
- Europe offers SCV as MEL relief for one HF
- Safety Issue – break down of separation
  - Incorrect use of SCV – increasing
  - Cannot use with reduced separation standards

THE FUTURE

- Satellite based CNS
- New Constellations
- New Receivers?
- Conflicting pressures
  - Fuel
  - Noise
  - Airspace and aerodrome saturation
- Is technology improving safety??

WORD FOR THE DAY

■**Nomophobia**

■ The fear of losing your mobile phone!!

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