ADS-X Extended ADS-B Surveillance

Alex Smith, CEO

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About Rannoch

- **Founded in 1991**
- **Home office in Alexandria, Virginia**
- **Global Presence**
  - Virginia, Massachusetts, Florida, California
  - Netherlands, Australia, Taiwan
- **Blue-Chip Customers**
  - Air Navigation Service Providers (ATC)
  - Airports
  - Defence Forces
- **Research and Development Culture**
  - Recognised safety and surveillance experts
  - Real time data collation and management
  - Portfolio of >25 patents

1998	Federal Computer Week Monticello Award
1998	NASA Group Achievement Award
1999	ATCA Chairman's Merit Award
2000	ATCA Charles Varnell Award
2001	NASA Turning Goals into Reality Award
2002	International Trade Association of North Virginia Award
2005	NASA Turning Goals into Reality Award

Patents

- 6,049,304 (4/11/00): Method and Apparatus for Improving the Accuracy of Relative Position Estimates In a Satellite-Based Navigation System
- 5,999,116 (12/07/99): Improving the Surveillance Coverage and Target Identification in a Radar Based Surveillance System
- 6,094,169 (07/25/00): Passive Multilateration Auto-Calibration and Position Error Correction
- 6,384,783 (05/07/02): Method and Apparatus for Correlating Flight Identification Data With Secondary Surveillance Radar Data
- 6,633,259 (10/14/03): Method and Apparatus For Improving The Utility of Automatic Dependent Surveillance
- 6,211,811 (04/02/01): Improving the Surveillance Coverage and Target Identification in a Radar Based Surveillance System
- 6,448,929: (09/10/02): Method and Apparatus for Correlating Flight Identification Data With Secondary Surveillance Radar Data
- 6,567,043: (05/20/03): Method and Apparatus for Improving the Utility of Automatic Dependent Surveillance
- 6,812,890 (11/02/04): Voice Recognition Landing Fee Billing System
- 6,885,340 (03/21/05): Correction of Transponder Derived Altitude Information
- 6,806,829 (10/19/04): Method and Apparatus For Improving the Utility of Automatic Dependent Surveillance
- 6,992,626 (1/31/06): Method and apparatus to correlate aircraft flight tracks and events with relevant airport operations information
- Filed (12/23/03): Method and Apparatus for Accurate Aircraft and Vehicle Tracking
- Filed (01/07/05): Land Use Compatibility Planning Software
- Filed (01/14/04): Minimum Safe Altitude Warning
- Filed (04/23/04): Correlation of Flight Track Data with Other Data Sources
- Filed (04/22/05): Aircraft Boundary Transition Warnings and Auto Alerting
- Filed (06/06/05): Airport Pavement Management System
- Filed (08/15/05): Automated Management of Airport Revenues
- Filed (08/25/05): Correlation of Flight Track Data with Other Data Sources
- Filed (2005): Method and apparatus to improve ADS-B Security
- Filed (2005): MLAT Enhancements for Noise and Operations Monitoring
- Filed (1/06): Use of Geostationary Satellites to Augment Wide Area Multilateration Synchronization

Products and Services

Air Traffic Control

Multilateration & ADS-B

Vehicle Tracking

A-SMGCS

Collision Avoidance

US FAA
NASA
Nav Canada
UK NATS
Taiwan CAA
Airways New Zealand
Mongolia CAA
Cairo - CAA

Airport Management

Noise & Emissions

Revenue Management

Gate Management

Airport Operations

USA: Ohio, Boston, Anchorage, Indianapolis, San Antonio, Raleigh Durham, Barnstable, Portland, Rhode Island, East Hampton, Louisville, Cincinnatti,

Canada: Calgary, Springbank

Japan: Nagoya, Tokyo

Military & Homeland Security

Passive Surveillance

Range Management

Aircraft Identification

Mobile Solutions

US Navy

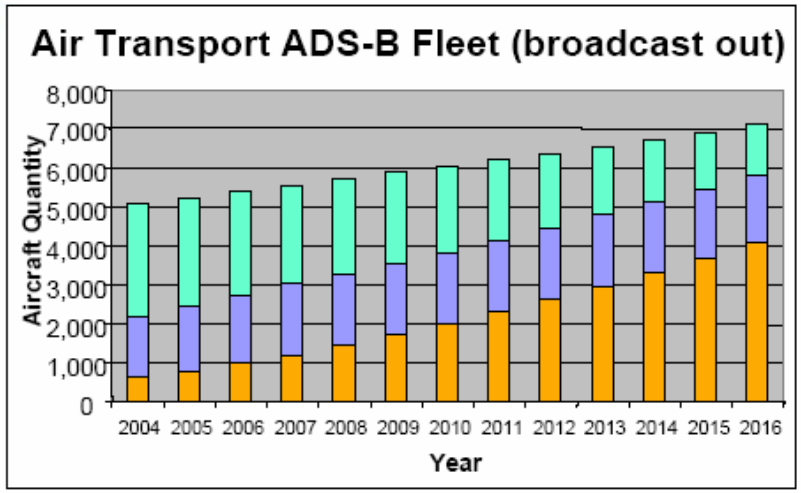
Canadian Dept of Defense

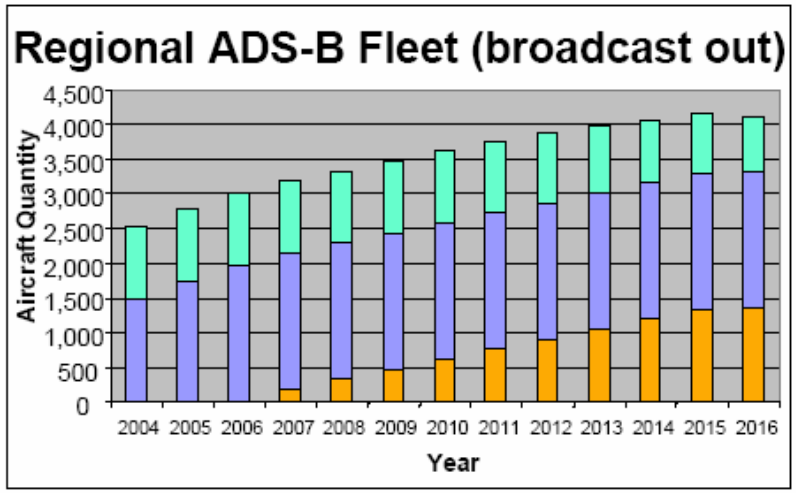
Integrated ADS-B Multilateration Surveillance ADS-X

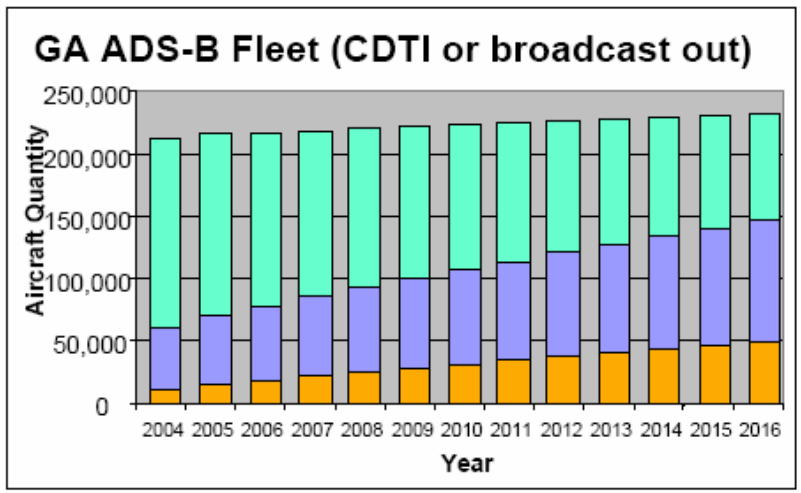
ADS-B will take a while

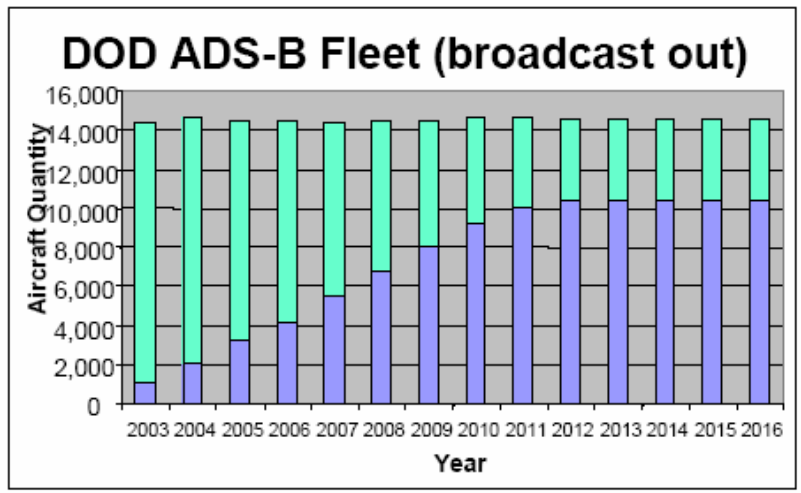
(Source: MITRE)

Capable Latent Not Equipped

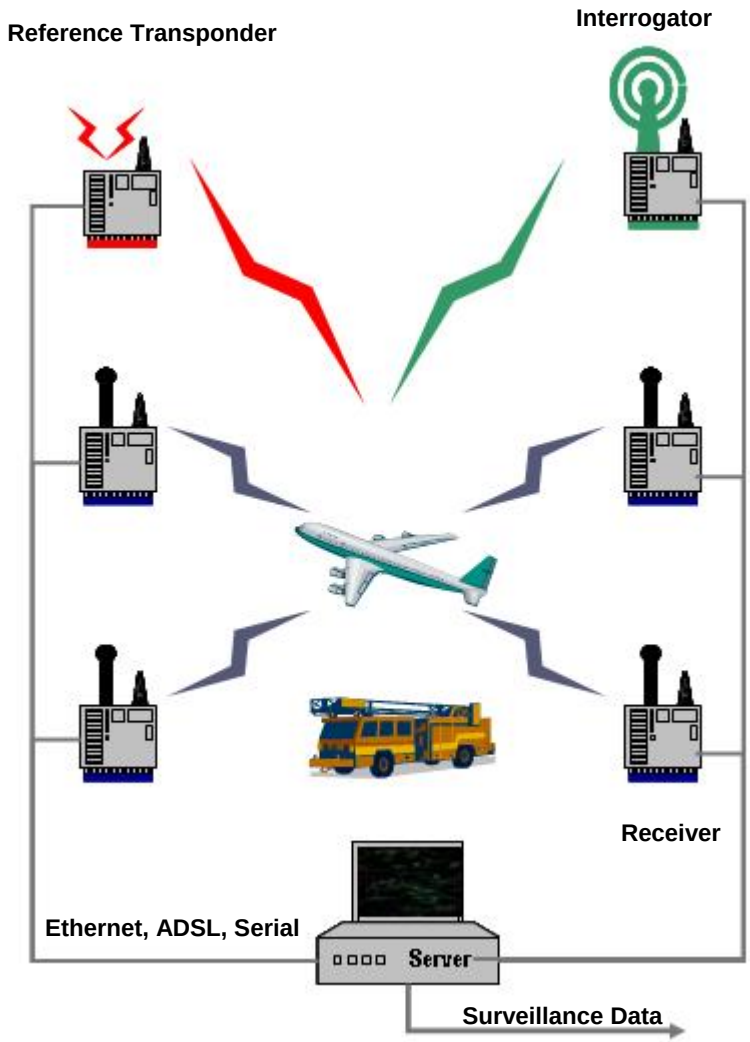








EXtended ADS-B Surveillance (ADS-X)

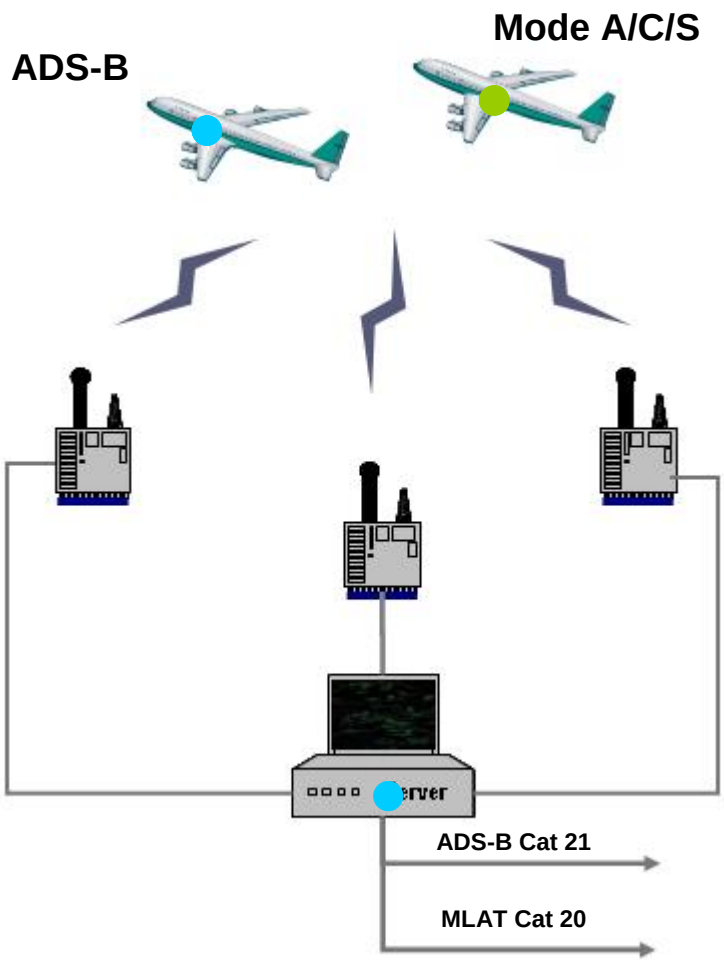


- 100% Standards-based ADS-B
- Time Difference of Arrival (TDOA) technique to also “triangulate” on aircraft transponder.
- Mode 3/A, C, S, ADS-B
- Passive or active
- Scale from an airport to a country
- Output ASTERIX formats
- Surface, Terminal Area, En Route

How Multilateration Works

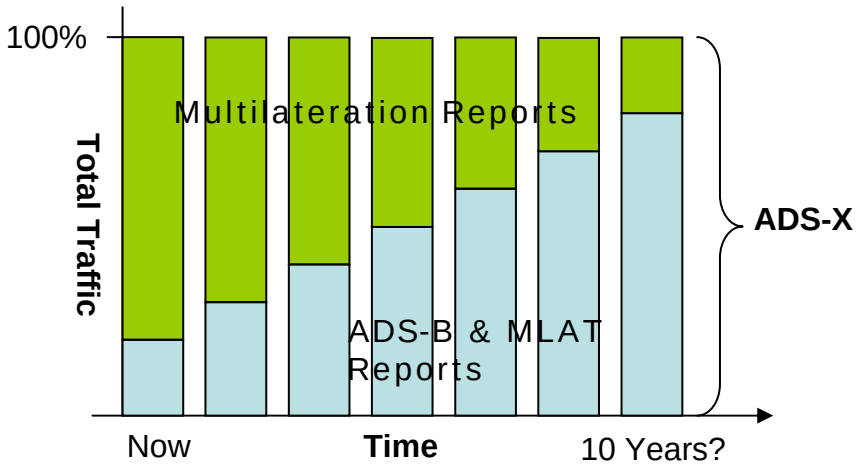
Multilateration Benefits

ADS-X – Simultaneous ADS-B/MLAT

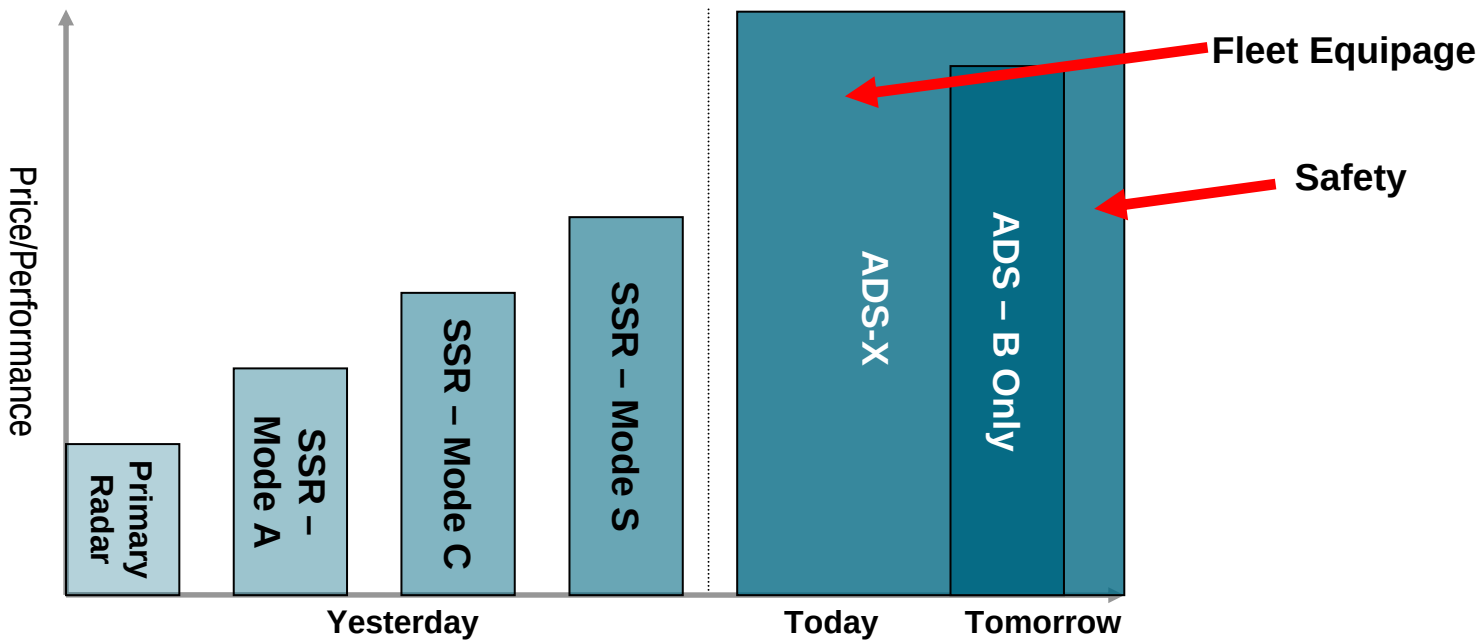


* Optional data fuse and alerts

- **ADS-X**
  - Requires no new avionics
  - Requires no big bang mandate
- **ADS-X position data is…**
  - Selected and installed by the ANSP
  - Maintained by the ANSP
  - Calibrated and validated by the ANSP



ADS-X – Effective ADS-B Implementation



ADS-X provides better fleet coverage and a more independent source of position than ADS-B reception alone whilst simultaneously providing totally compliant ADS-B decoding.

The use of multilateration as an independent means of surveillance for backup or verification of ADS-B should be further considered. This is specifically to identify credible errors in ADS-B position.

Source: NATS, UK

Integration of ADS-X with existing ATC

Physical interface

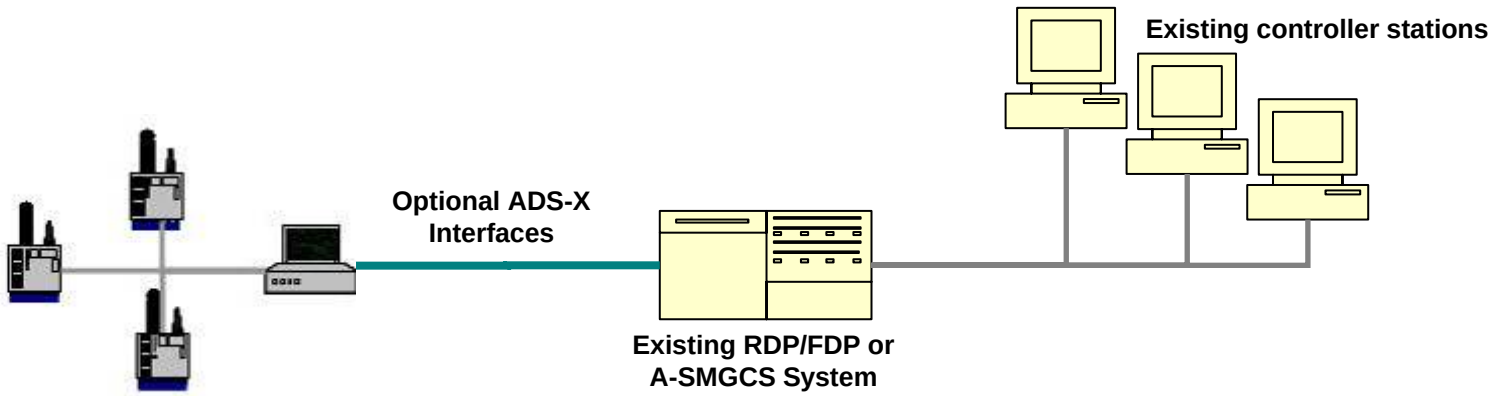
- Ethernet (TCP/IP) or Serial

ASTERIX Support

- ADS-X Mode 1 — Simultaneous separate CAT020 and CAT021 feeds
- ADS-X Mode 2 — Fused CAT021 feed using MLAT data to create Pseudo ADS-B records
- ADS-X Mode 3 — Fused CAT020 MLAT feed using ADS-B data to improve data & tracking
- ADS-X Mode 4 — Fused Cat001/048 feed with fused data output in a pseudo-radar (sweep) fomat.

Custom Interface

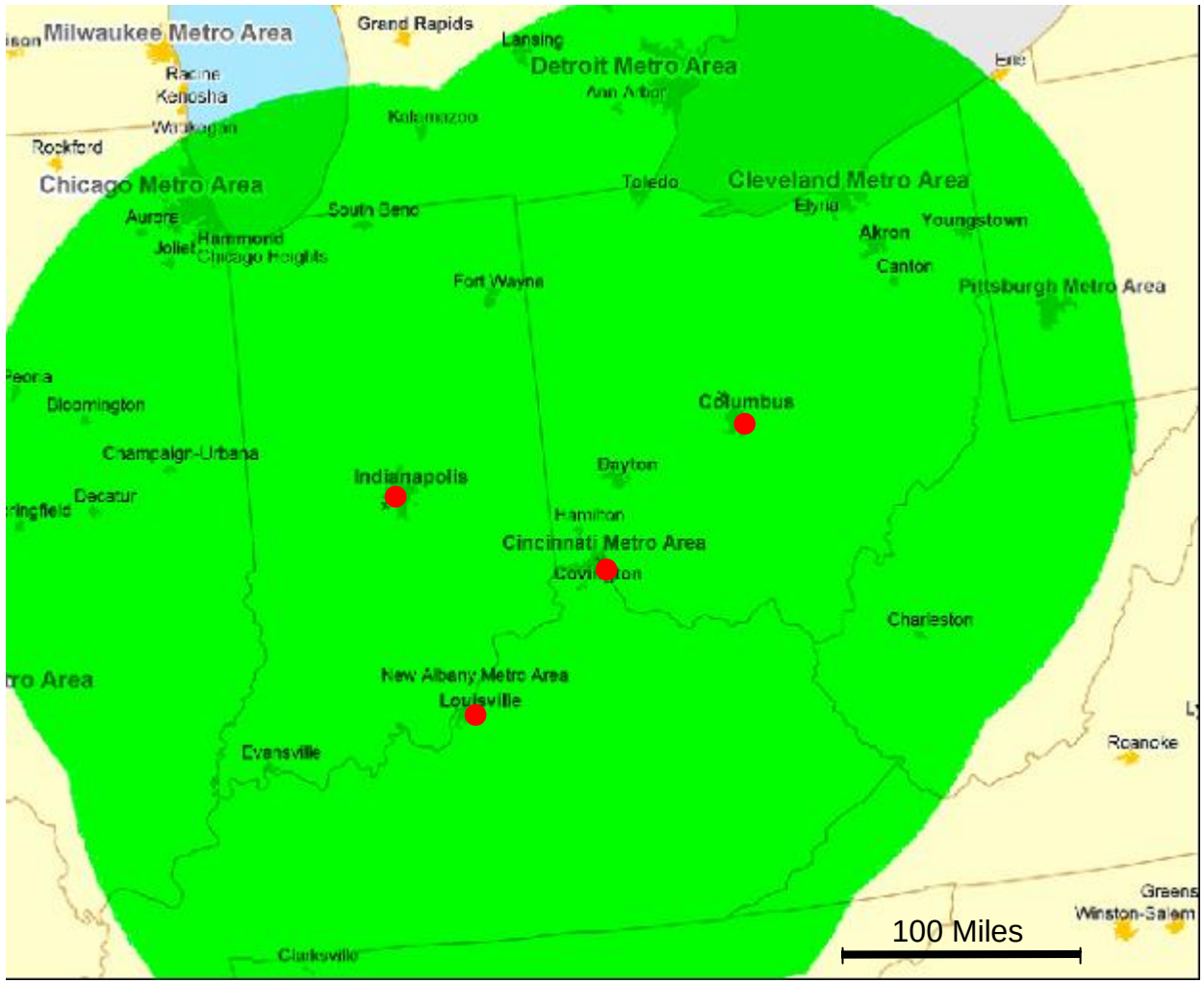
- Legacy ATC Automation systems



ADS-X is incremental investment

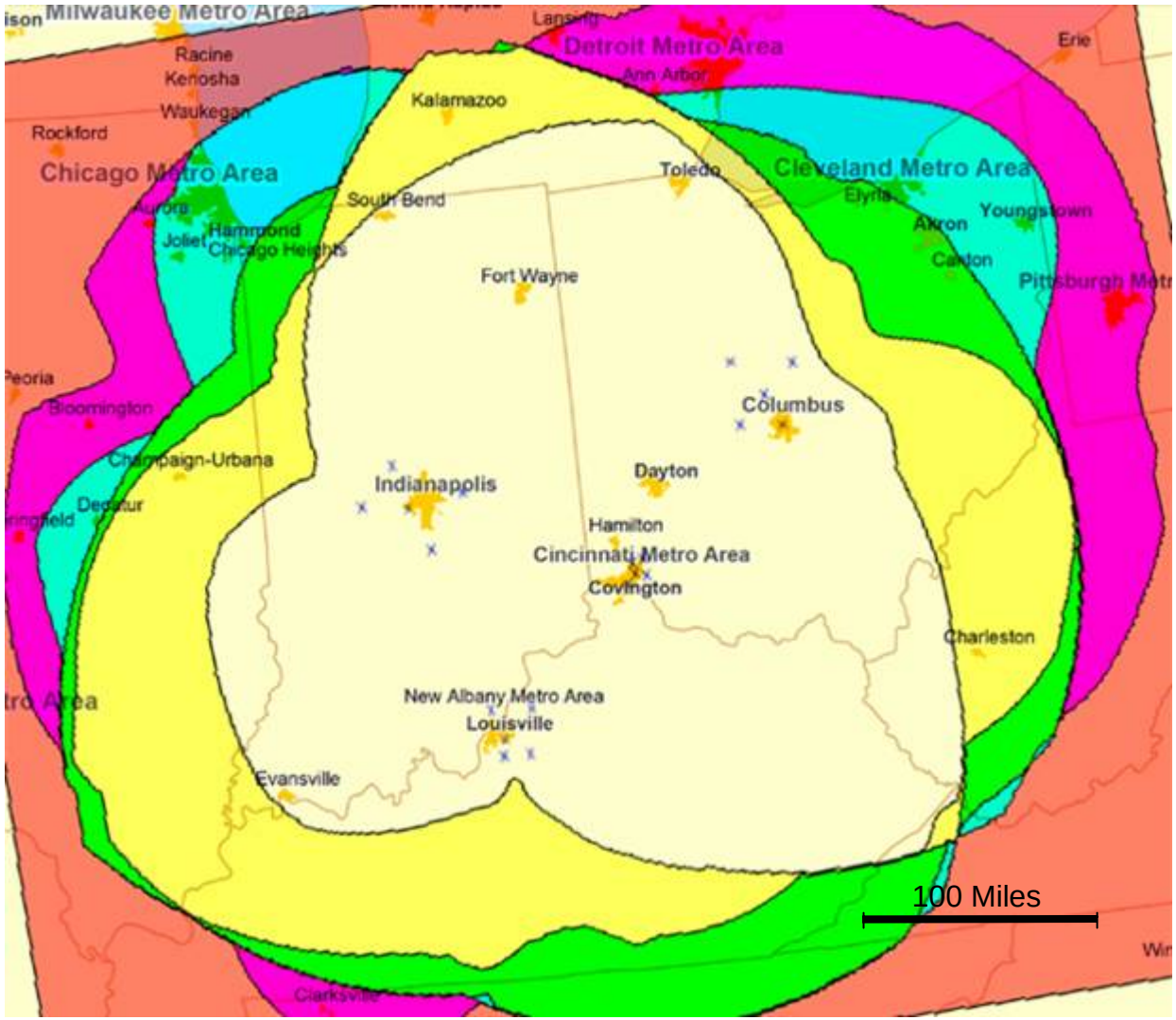
- **ADS-X <u>does not</u> mean 3 or 4 times the ground stations**
  - ADS-B should have redundancy and geo-diversity
  - Ranging reduces ADS-X ground station requirements
  - Use WAMLAT in dense areas and to create verification zones
- **ADS-X <u>does not</u> mean 3 or 4 times the cost**
  - Incremental cost of additional IAMS ground stations is low
- **Interrogation is also distributed**
  - Lower power, omni-directional interrogation

Example: 4 US Airports
ADS-B Receiver at each airport



18,000 ft coverage

Example: 4 US Airports
Existing ADS-X system at each airport

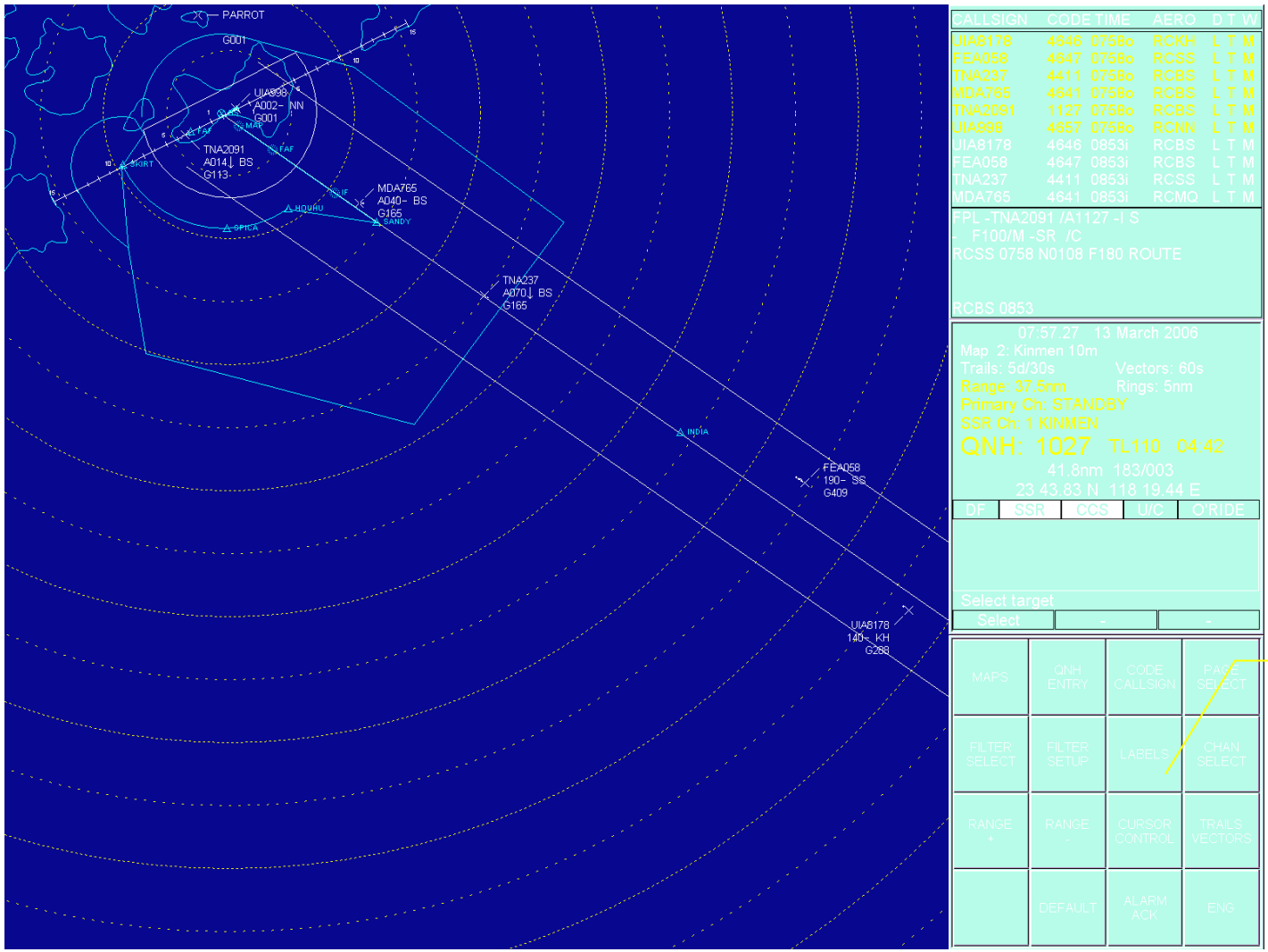


<25
25 to 100
100 to 320
320 to 666
666 to 1333
Over 1333

Accuracy in Metres RMS

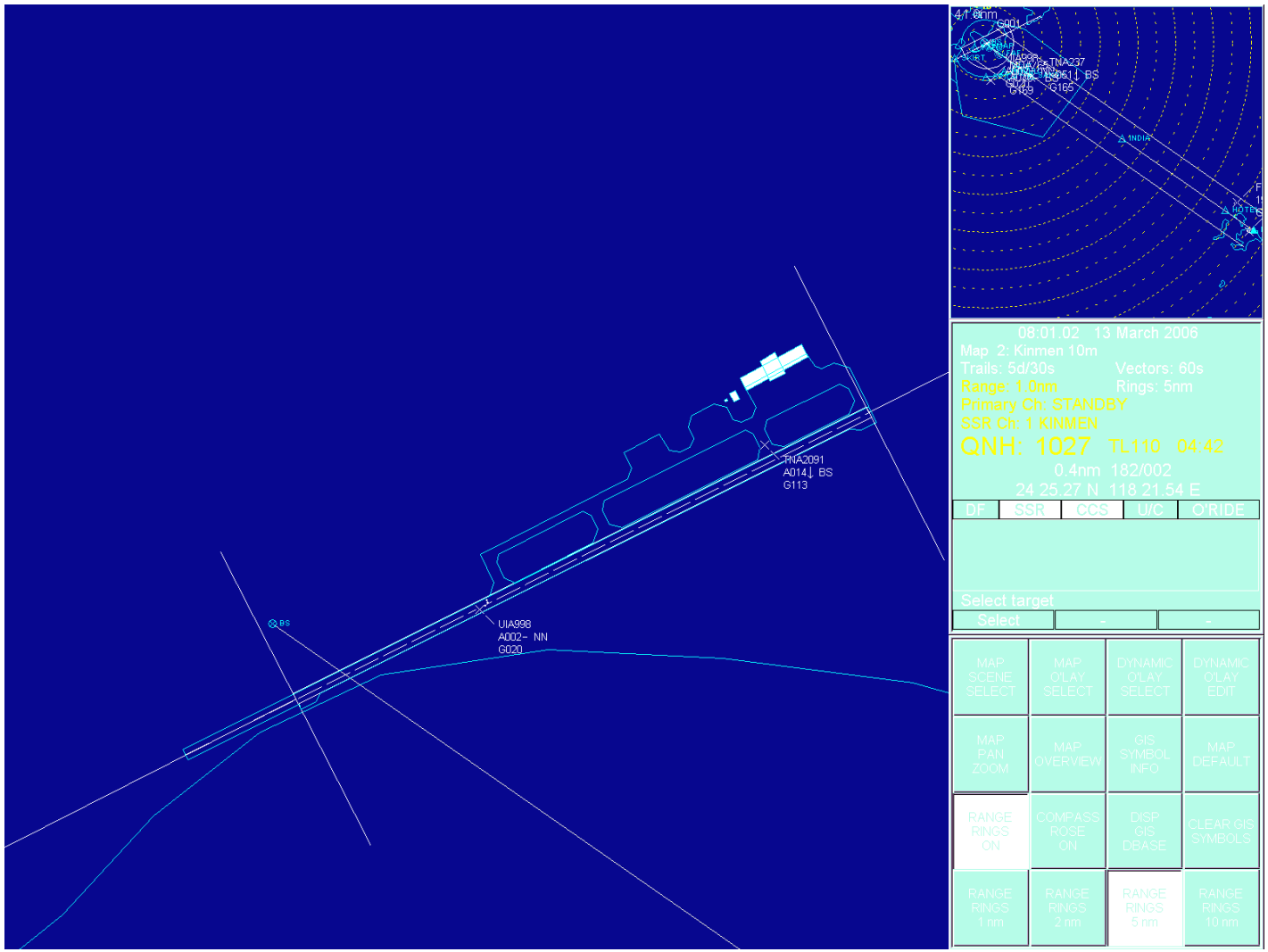
18,000 ft coverage

Taiwan, En Route Solution

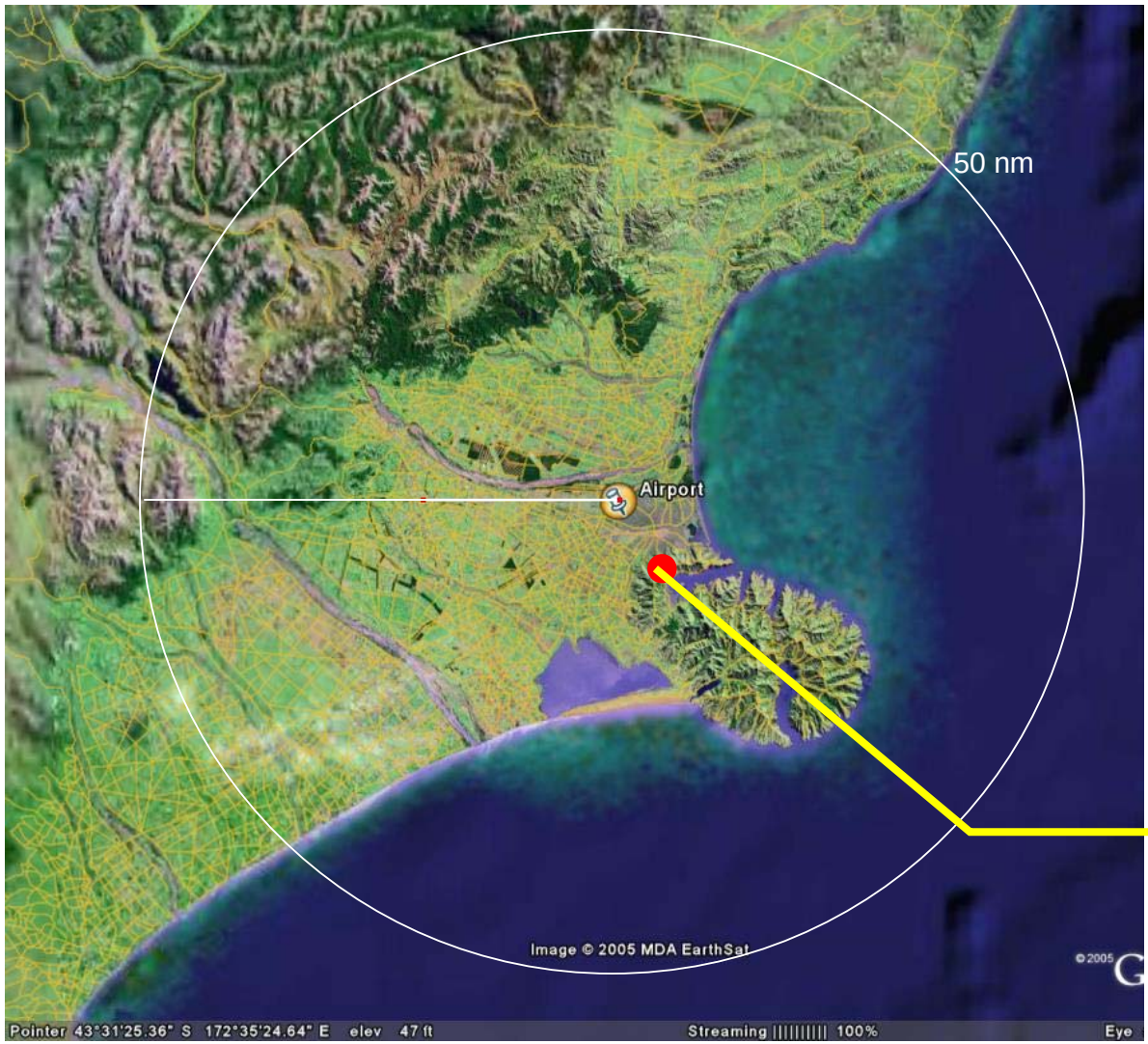


HMI Options on screen and on custom keypad

Taiwan, Surface Solution



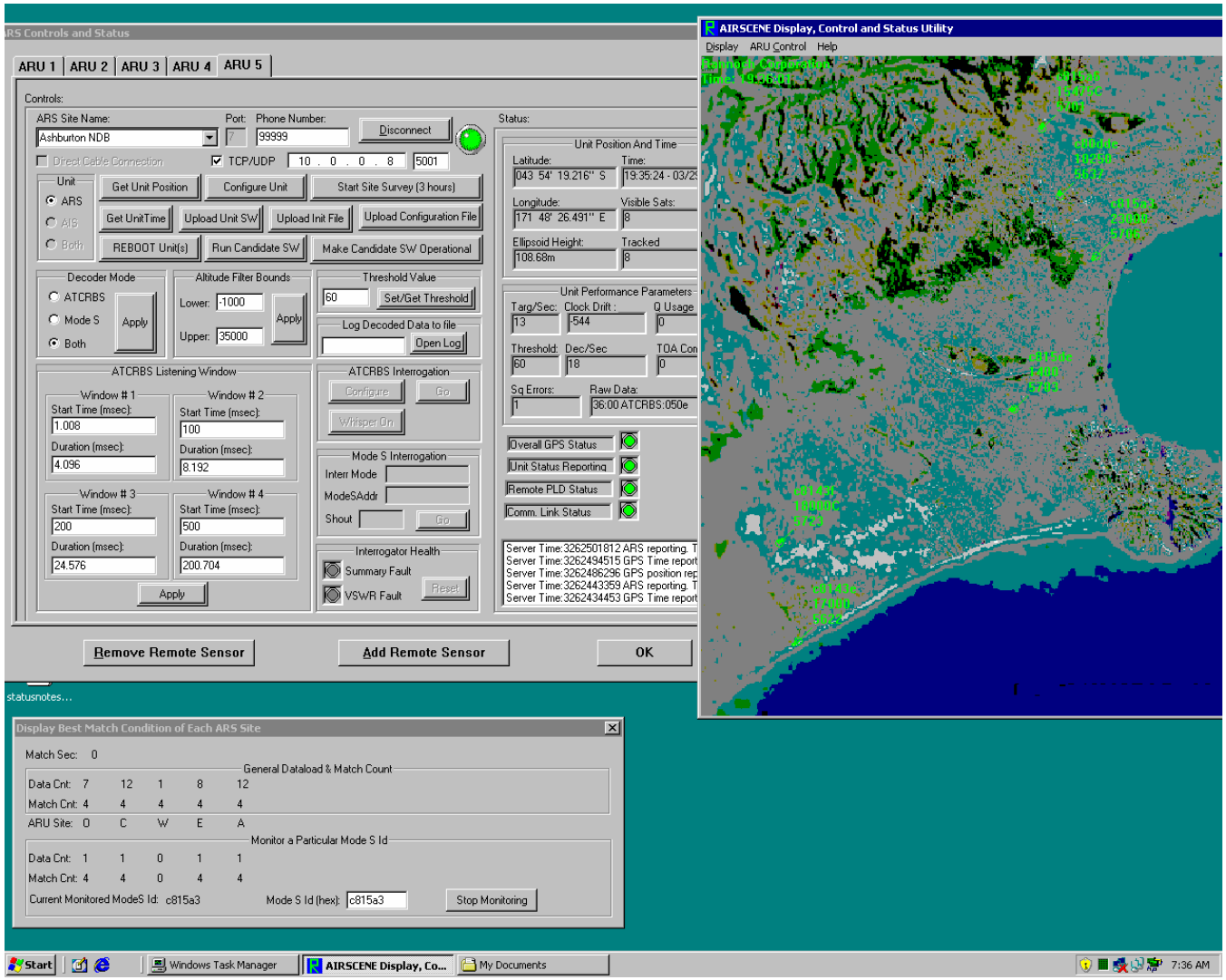
Airways New Zealand, Christchurch



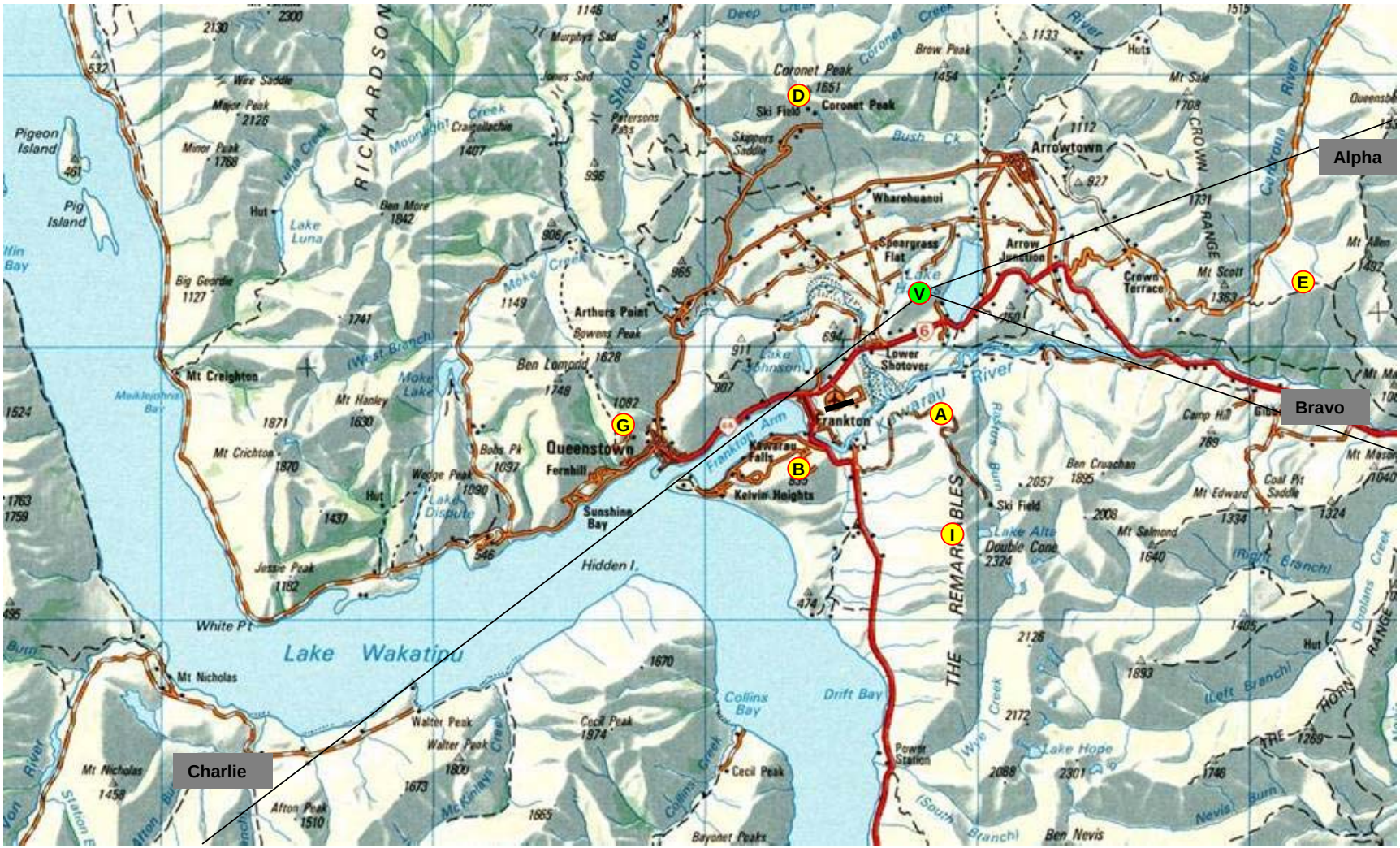
- **Terminal area coverage of CHC**
- **Passive System**
  - Existing SSR
- **Existing navaid sites**
  - NDB, VOR etc.
- **Interface with LM Skyline**

Existing SSR at Cass Peak

Christchurch Screenshots



Airways New Zealand, Queenstown


Alpha
Bravo
Charlie
Queenstown
Frankton
Arrowtown
Lake Wakatipu
Coronet Peak
Ski Field
Kelvin Heights
Kawarau Falls
Lower Shotover
Arrow Junction
Wharehuanui
Speargrass Flat
Crown Terrace
Arthurs Point
Sunshine Bay
Fernhill
Hidden I.
Pigeon Island
Pig Island
Mt Creighton
Mt Crichton
Mt Nicholas
Walter Peak
Cecil Peak
Bayonet Peaks
Collins Bay
Drift Bay
Ben Lomond
Ben Cruachan
Double Cone
Ben Nevis
Mt Scott
Mt Allen
Mt Edward
Mt Salmond
Camp Hill
Coal Pit Saddle
Lake Hope
Lake Luna
Lake Dispute
Lake Johnson
Lake Alta
Frankton Arm
Kawarau River
Shotover River
Clutha River
RICHARDSON
THE REMARKABLES
CROWN RANGE
THE HORN
RANGE
Moke Creek
Moonlight Creek
Coronet Creek
Deep Creek
Bush Ck
Mt Sale
Brow Peak
Huts
Hut
Big Geordie
Ben More
Jessie Peak
Afton Peak
Mt Hanley
Bobs Pk
Wedge Peak
Skippers Saddle
Patersons Pass
Murphys Sad
James Sad
Wire Saddle
Major Peak
Minor Peak
Craigellachie
Bowens Peak
Mt Nicholas
White Pt
Powder Station
Left Branch
Right Branch
South Branch
West Branch
Nevis Burn
Dicklans Creek
Wye Creek
Mt Nicholas Bay
Mt Nicholas Station
Mt Nicholas Burn
Afton Burn
Mt Kinlays Creek
Walter Peak Creek
Collins Creek
Kawarau Burn
Shotover River
Clutha River
Deep Creek
Coronet Creek
Moke Creek
Moonlight Creek
Lake Luna
Lake Dispute
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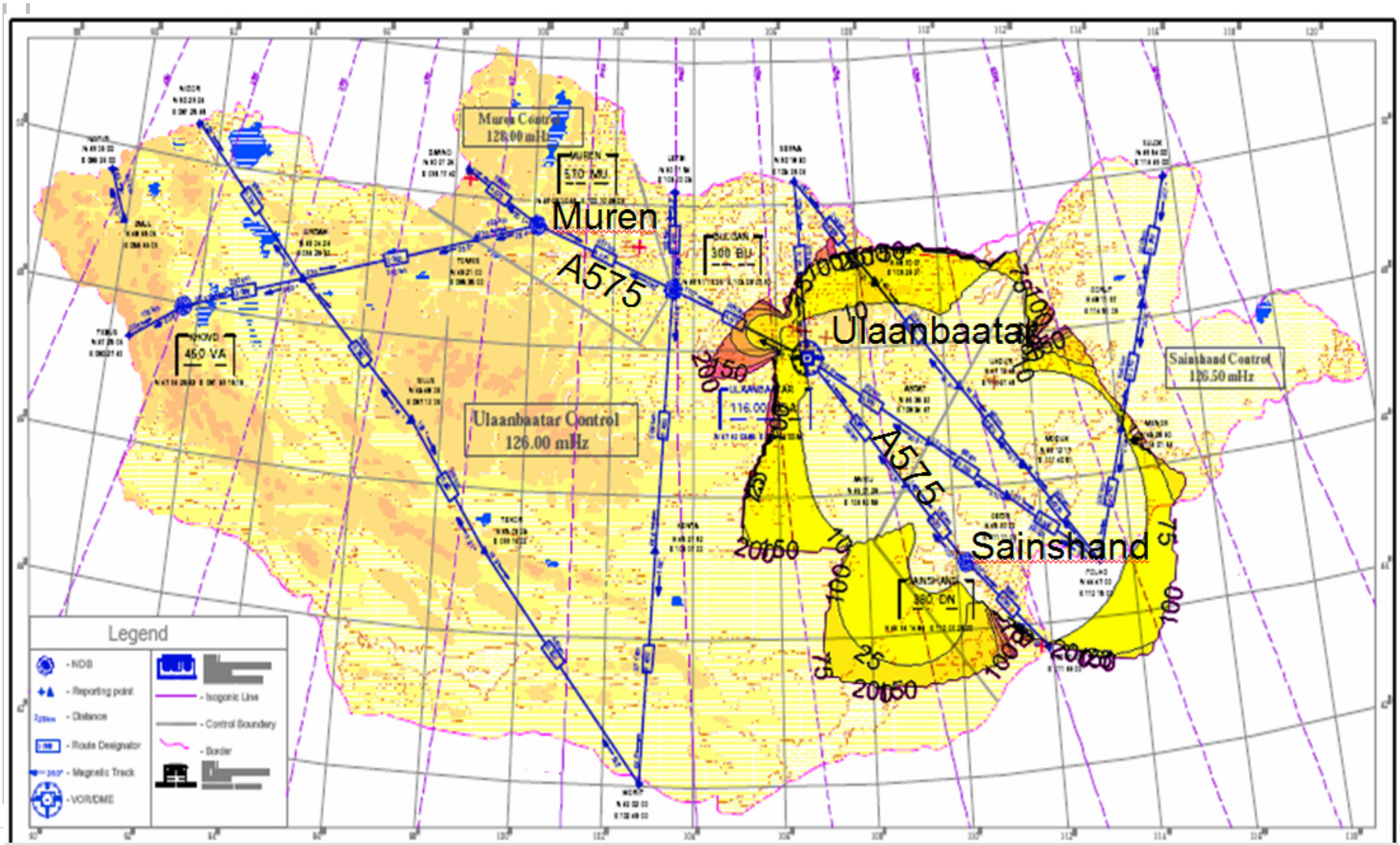
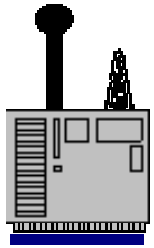
Lake Hope
Frankton Arm
Kawarau River
Shotover River
Clutha River
Pigeon Island
Pig Island

CAA, Mongolia



RANNOCH ADS-X TECHNOLOGY ARCHITECTURE

ADS-X Solution Elements



AirScene **ADS-X Ground Station**

- Highly configurable
- Timing synchronisation from GNSS or Reference Transponder

AirScene **ADS-X Server**

- Hot standby redundant configuration
- Maintenance display and configuration

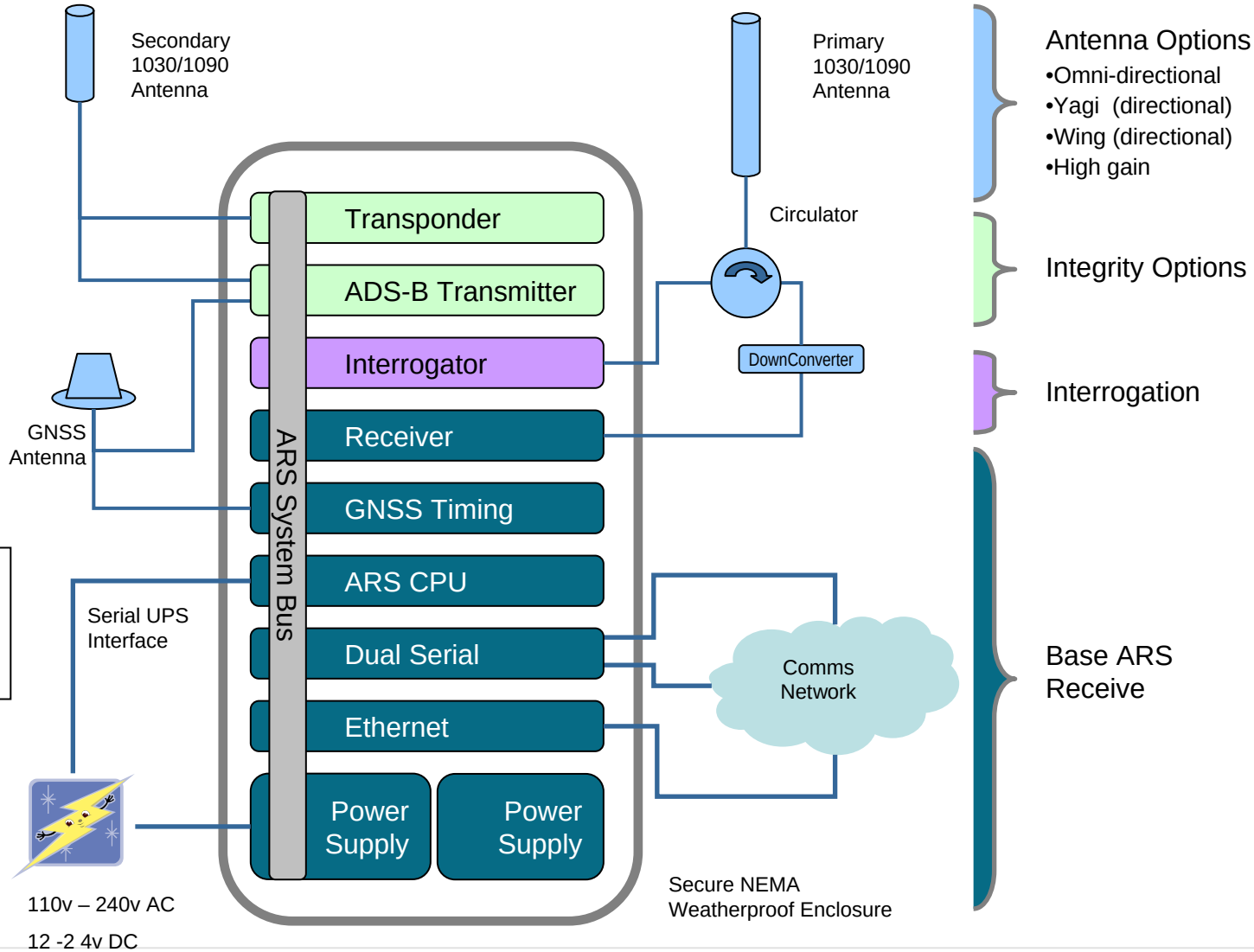
AirScene **ADS-X Remote Workstation**

- Remote system management and control
- SMTP Management Agents

AirScene **Vehicle Transponder**

- Vehicle mounted multi-mode ADS-B transmitter
- Intelli-squit and moving map display options

AirScene ADS-X Ground Station



Optional

UAT

Reference timing

Conclusion

- **Rannoch is a leader in ADS-B & multilateration**
  - Advanced, patented technology
  - Many installed, operational systems
  - Surface, terminal area, en route
  - Asia – Taiwan, Japan, Mongolia, New Zealand
- **ADS-X – EXTended ADS-B**
  - Fleet coverage today with no new avionics
  - Independent position validation
- **Rannoch technology differences**
  - Surface to en-route – same technology
  - Low bandwidth required to ground stations
  - Synchronisation options (GNSS, Reference, Other)
- **Rannoch advantages**
  - History and track record of innovation & deployment
  - Airport Management Server options