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Sharing of Singapore's experience

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Topics

- Collaboration with neighbours
- System Implementation
- Operations
- Safety Case
- Space-based ADS-B

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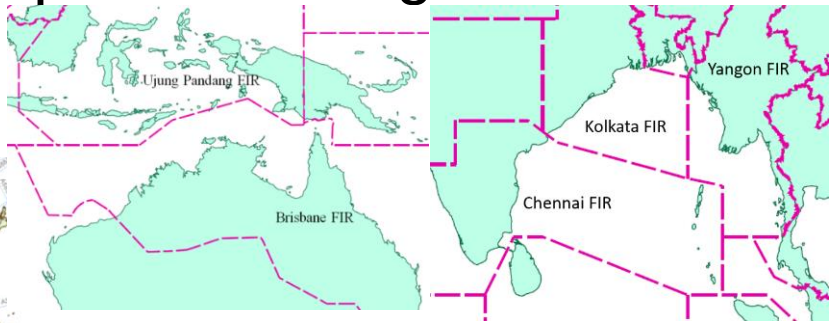
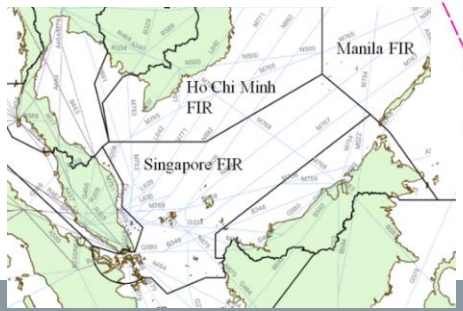
Collaboration with neighbours

ICAO ADS-B Working Group

- In 2007, the first ADS-B Working Group meeting
  - Identified areas for enhancement
  - Express desire to enhance surveillance via collaboration
- Main projects identified in subsequent meetings
  - Australia and Indonesia
  - South China Sea
  - Bay of Bengal





ADS-B Collaboration is Encouraged by Aviation Community

- ICAO
  - formed task force to implement ADS-B
  - formed working group to facilitate ADS-B data sharing
  - ICAO urged States sharing ADS-B to consider provision of VHF
- IATA
  - urged ANSPs to enhance surveillance / communications via collaboration
- CANSO
  - urged collaboration among ANSPs

Achievement of the ADS-B Working Group

- Under the leadership of ICAO, data sharing agreements were signed between the following pairs of States:
  - Australia and Indonesia
  - Indonesia and Singapore
  - Singapore and Vietnam
  - India and Myanmar
  - Singapore and the Philippines
  - Brunei and Singapore

Finalisation of Agreements

- Multiple meetings to finalise collaboration agreement
- Issues to overcome:
  - Cost
  - Sensitivity (e.g. military)
  - Politics
  - Approval from various authorities
  - Applicable law
  - Dispute resolution
  - Duration

Agreements involving Singapore

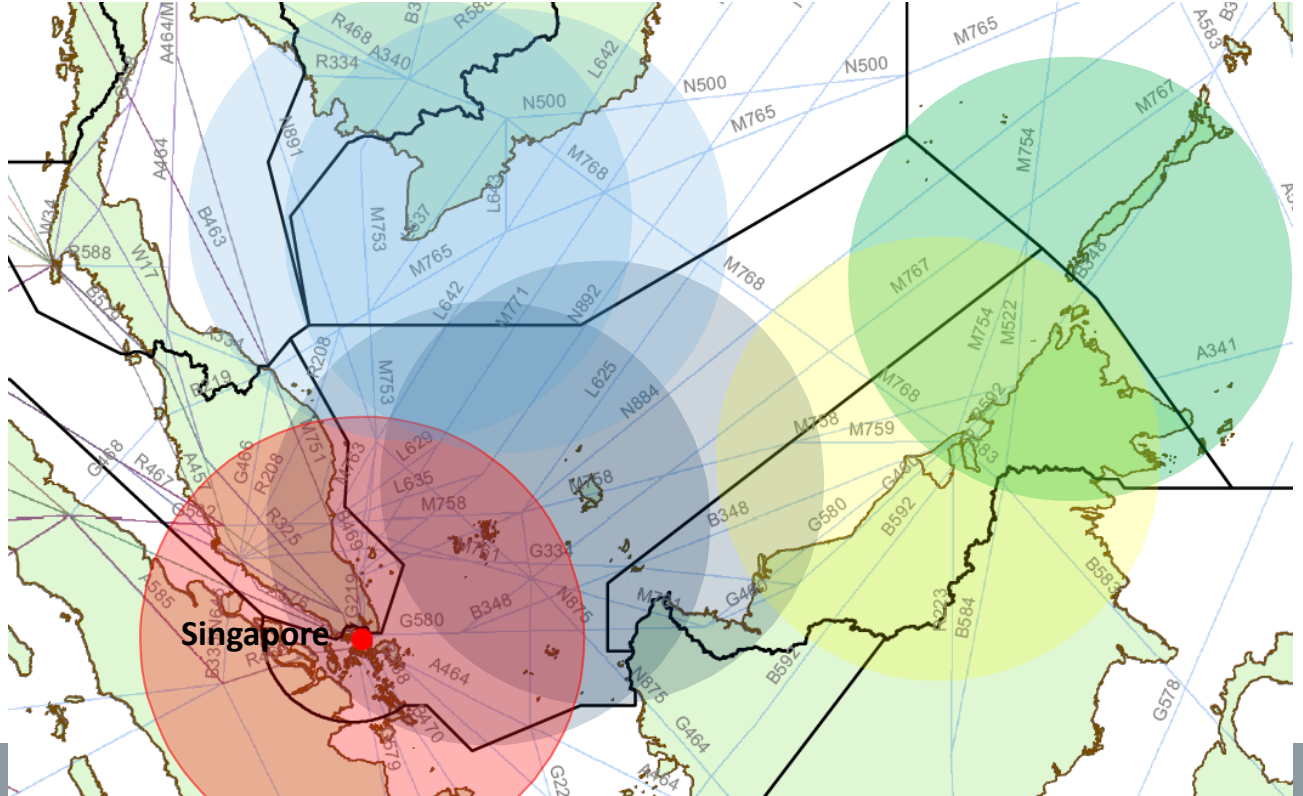
- Indonesia – Singapore Agreement
  - Signed in Dec 2010
- Singapore – Vietnam Agreement
  - Signed in Nov 2011
- The Philippines – Singapore Agreement
  - Signed in Oct 2015

Agreements involving Singapore

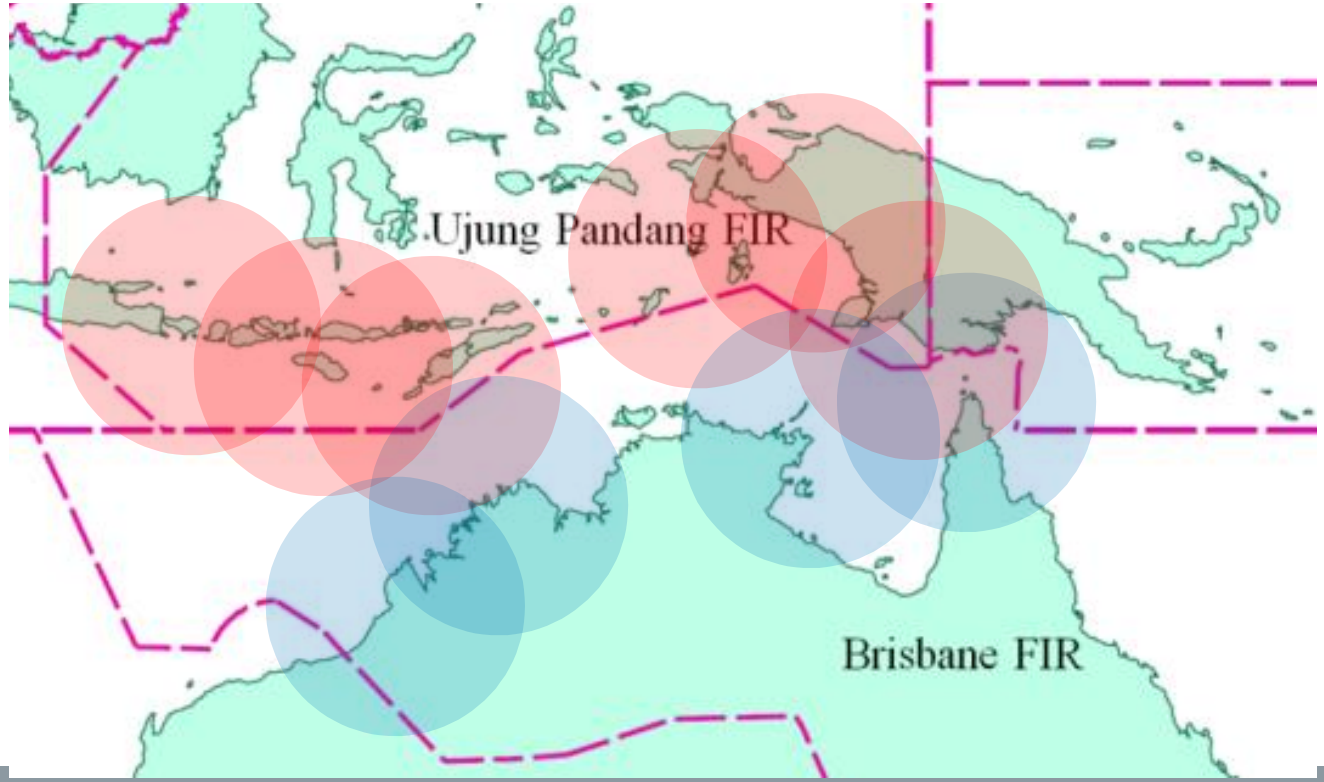
- Singapore – Vietnam Agreement (second agreement)
  - Signed in Jul 2016

- Brunei – Singapore Agreement
  - Signed in Apr 2019

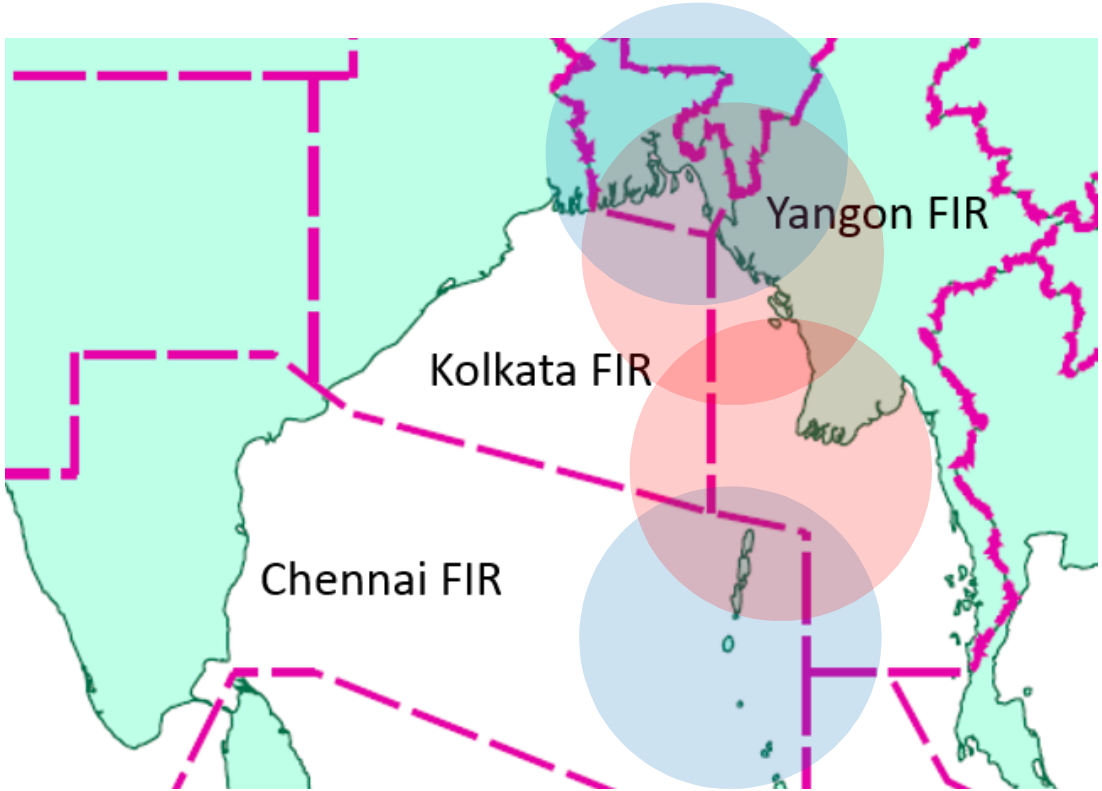
Enhanced Sur/comms coverage



Data sharing between Australia and Indonesia



Data sharing between India and Myanmar



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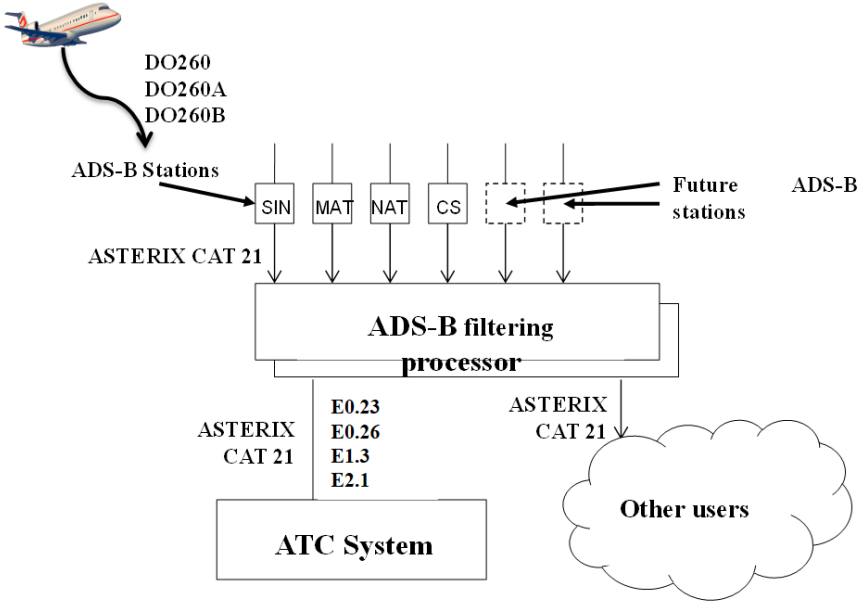
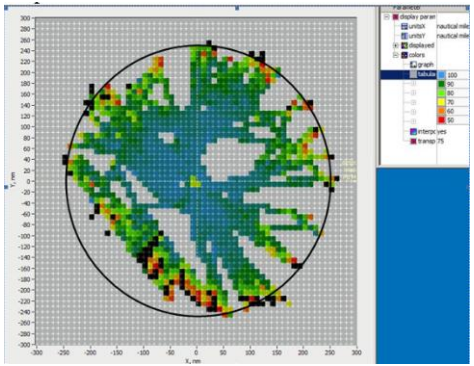
System implementation

Managing different inputs and outputs



System Implementation Issues

- Conduct flight checks
  - Check ADS-B coverage
    - Shifted antenna to improve performance
  - Check VHF coverage
- Measure PD using the SMS system
  - To ensure regulation requirement is met
  - Check for deterioration of station
- Overcoming noisy environment
  - Due to proximity to radars
  - Implemented pre-amplifier



System Implementation Issues

- Time-stamp issues
  - Due to faulty GPS receiver
  - Due to network congestion
  - Data will be unusable
- Time – lag of VHF
  - Due to satellite link
  - Controllers to adapt to time-lag
- Aircraft performance
  - Poor NUC
    - Cannot be displayed to controllers
    - To inform airlines for servicing
  - Shared list of aircraft issues

Handling of Distress Code

- In radars, distress codes obtained via Mode A
  - 7500 unlawful interference
  - 7600 no communications
  - 7700 general emergency
- In ADS-B, distress code is in Aircraft Status Message (type code 28)
  - Mode A code only available in DO-260B
  - Mode A code may be available for DO-260/DO-260A when installed near Mode S interrogator
    - Not available when coming thru space-based ADS-B
  - Emergency status is shown at the I021/200 of the Asterix message
    - Need to ensure that ATM system can interpret

Handling of Distress Code

- Need to ensure that ATM system can interpret “priority status”

5.2.34 Data Item I021/200, Target Status

Definition : Status of the target
Format : One-octet fixed length Data Item
Structure:

Octet no. 1

8	7	6	5	4	3	2	1
ICF	LNAV	0	PS			SS	

bit-8 (ICF) Intent Change Flag (see Note)
=0 No intent change active
=1 Intent change flag raised

bit-7 (LNAV) LNAV Mode
=0 LNAV Mode engaged
=1 LNAV Mode not engaged

bit-6 Spare bit, set to “0”

bits-5/3 (PS) Priority Status
= 0 No emergency / not reported
= 1 General emergency
= 2 Lifeguard / medical emergency
= 3 Minimum fuel
= 4 No communications
= 5 Unlawful interference
= 6 “Downed” Aircraft

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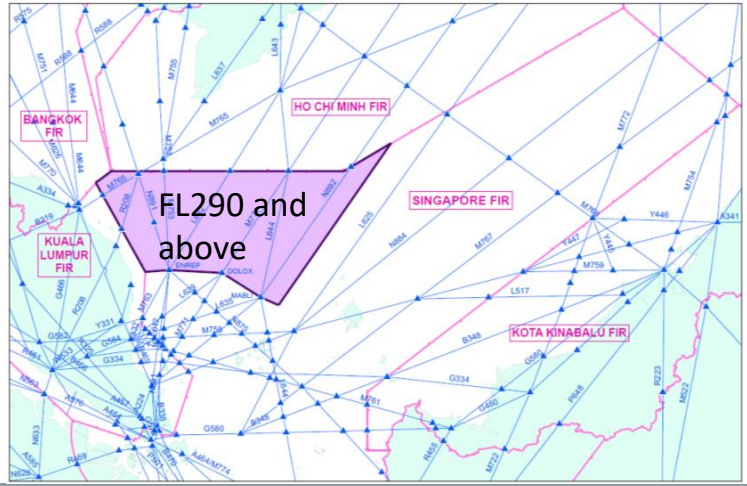
Operations

Publication of ADS-B requirements

- Publication of ADS-B requirements and delineation of exclusive ADS-B routes on 28 Dec 2010
- Operational requirements (effective 12 Dec 2013, subsequently amended):
  - EASA AMC 20-24, or Appendix XI of Civil Aviation Order 20.18 of CASA Australia; and
  - Relevant operational approval from the State of Registry.
- Most airlines managed to meet timeline

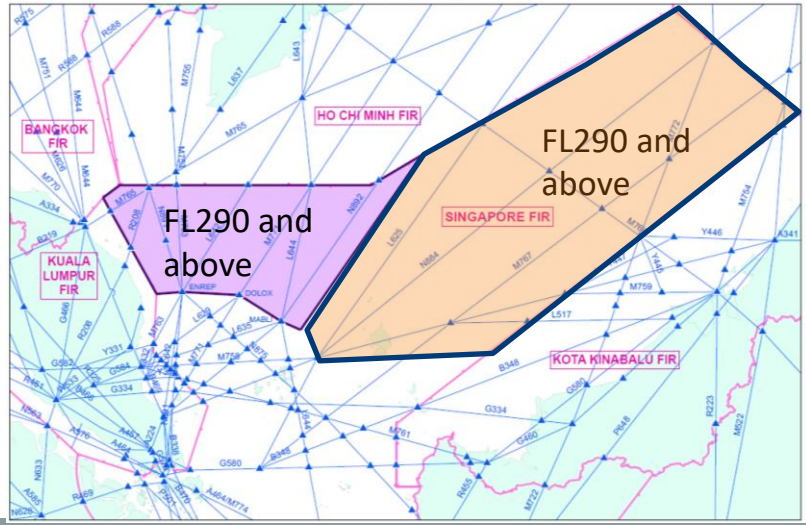


Amendments to the ADS-B requirements

- Original requirement (published in Dec 2010)
  - EASA AMC 20-24, or Appendix XI of Civil Aviation Order 20.18 of CASA Australia; and
  - Relevant operational approval from the State of Registry.
- Revised requirement (updated in Nov 2015)
  - EASA AMC 20-24, or FAA AC No. 20-165A, or Appendix XI of Civil Aviation Order 20.18 of the CASA Australia
  - Changes: Addition of FAA standard and removal of operational approval
- Revised requirement (updated in May 2018)
  - EASA ACNS, or EASA AMC 20-24, or FAA AC No. 20-165A, or Appendix XI of Civil Aviation Order 20.18 of the CASA Australia
  - Changes: Addition of EASA ACNS

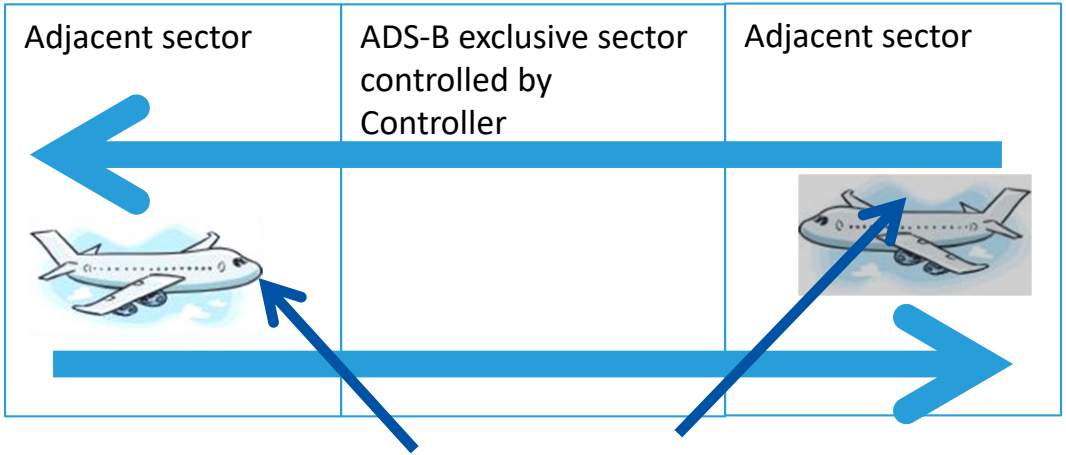
2nd Publication of ADS-B requirements

- ADS-B out requirements and delineation of exclusive ADS-B routes from 27 Jan 2022 from FL290 and above (orange area)
- ADS-B requirements and delineation of exclusive ADS-B routes from 26 Jan 2023 (rest of Singapore FIR from FL290 and above for all ATS routes except R208, M522, M754 and M765)



Identification of ADS-B aircraft

Controller for ADS-B exclusive sector use the ‘ADS-B only’ mode

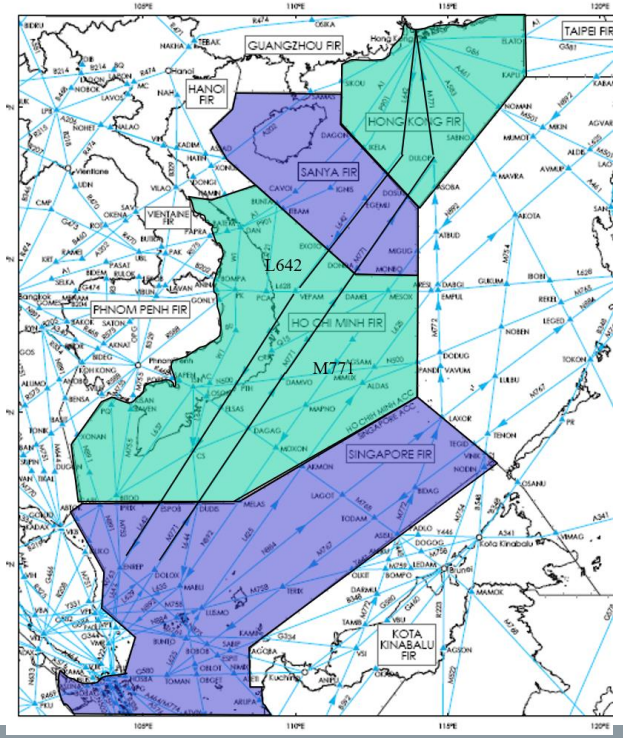


Automation System coupling

- Flight plan couples with ADS-B track in following order:
  - Mode A code
    - SSR is usually assigned by ground station that could lead to error when it is recycled too fast.
  - 24 bit code
    - 24 bit code is supposed to be unique id code(similar to aircraft registration)
  - Flight ID
    - Flight id is supposed to be same as Aircraft ID in flight plan

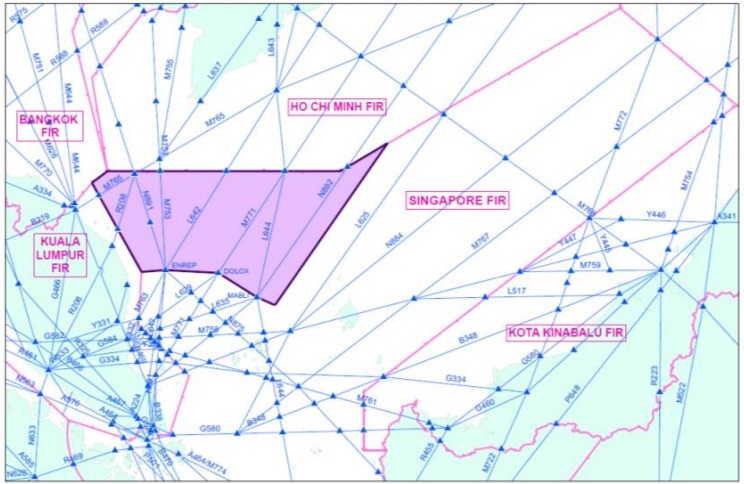
Coordination across FIRs

- Coordination across FIRs is needed to ensure seamless operations
- Items to coordinate includes:
  - ADS-B standards
  - Aircraft separation
  - Applicable flight levels



Reduction of Separation

- Separation Minima reduced in the following manner:
  - Between 50NM to 80NM
    - Before 12 December 2013
  - 40NM
    - On 12 December 2013
  - 30 NM
    - On 26th June 2014; and
  - 20 NM
    - On 10th November 2016.



Safety case

Initial safety case

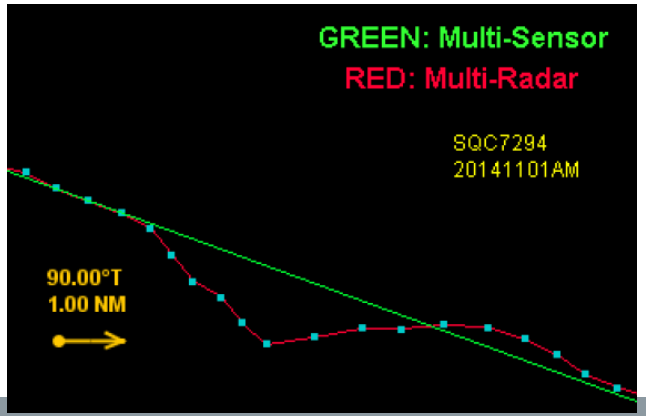
- Initially it is intended to do safety case for whole FIR
  - FIR consisted of both ADS-B-NRA and ADS-B-RAD
  - Fleet equipage fulfils ADS-B-NRA (ED-126/DO-303)
  - Fleet equipage does not fulfil ADS-B-RAD (ED-161/ DO-318)
    - ED-161 requires aircraft to have DO-260A or DO-260B
    - Most aircraft are still DO-260
- Safety case reduced to only ADS-B-NRA
- ADS-B can only be used for ADS-B-NRA
  - Do not mix ADS-B with radar
  - ADS-B to be used by controllers for the newly formed “ADS-B sector”

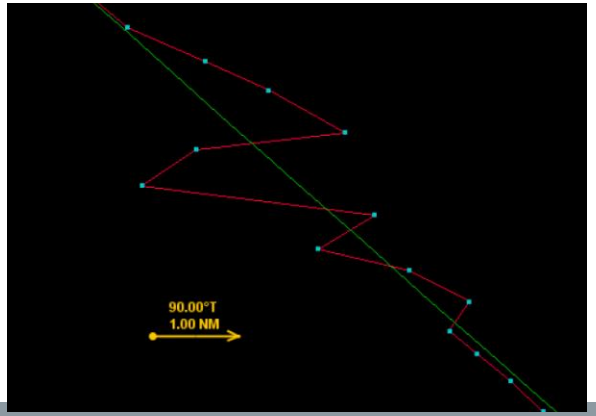
Subsequent safety case

- To mix ADS-B data (including DO-260) with radar data without change in operations
  - Radar separation only apply when at least one radar exist
  - Procedural separation has to be applied when all radars fail
- CAAS studied the impact of ADS-B data on radar data
  - By comparing Multi Sensor Track (radars with ADS-B) and Multi Radar Track (radars)

Safety assessment

- MST (radars + ADS-B) is no worse off than MRT (radars only)
  - When MST display different positions from MRT, its mainly due to instability in MRT
  - MST tend to have less ‘large jumps’ and ‘abnormal sharp turns’





Safety Assessment

- Minimal Hazard
  - Main hazard is the loss of ADS-B and incorrect ADS-B data
  - Loss of ADS-B is mitigated by the fact that there are radars
  - Incorrect ADS-B data is mitigated by alerts
    - e.g. split tracks, duplicate identity
- Other considerations
  - 96% of the flights are equipped with ADS-B (2015)
  - 99% of the ADS-B data has NUC of 5 and above
  - 90% of the ADS-B data has updates faster than 3s

Commencement of use

- Use of MST in all sectors, except the ADS-B airspace, on 22 August 2016, 0001UTC
- No change in procedures
- Benefits include
  - Faster identification of tracks during take-off
  - Less coasting of tracks as ADS-B bridges some of the ‘radar holes’

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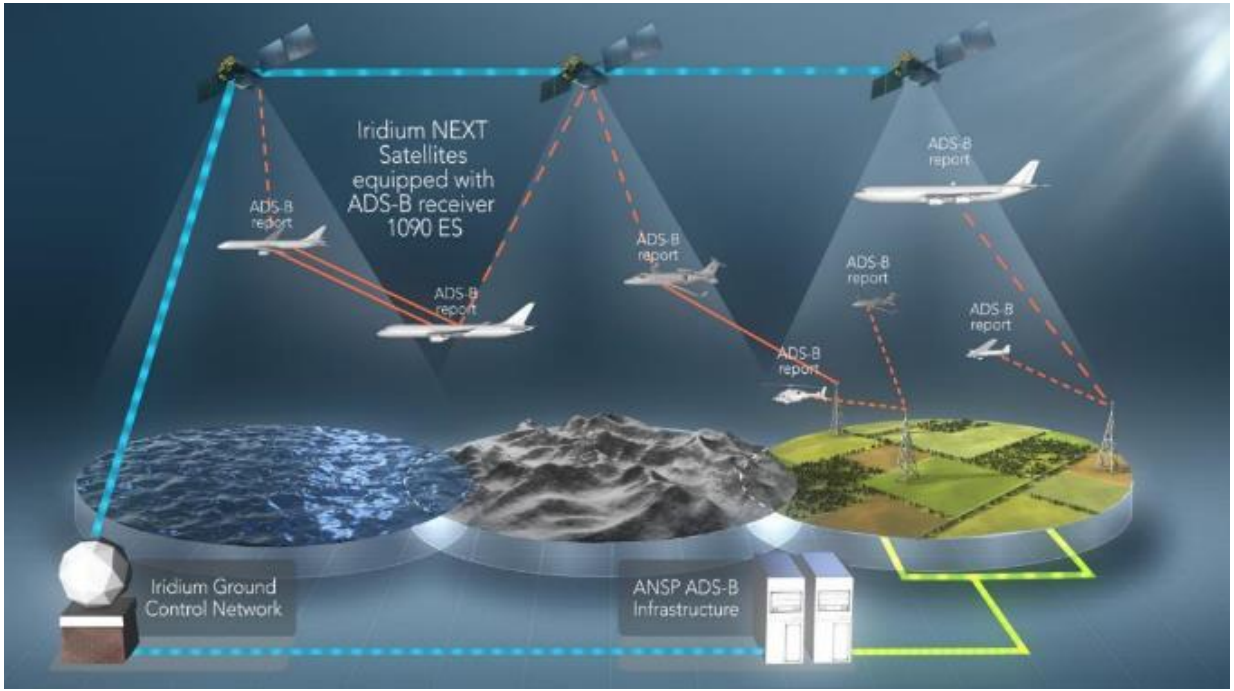
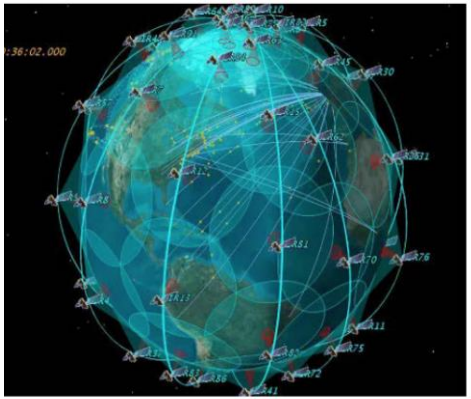
Space-based ADS-B

Space based ADS-B

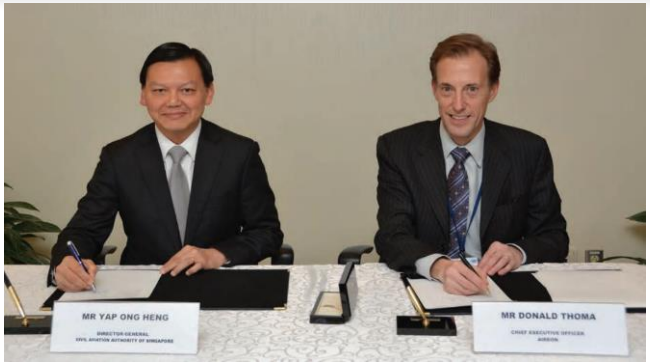




Pictures obtained from Aireon's presentation

Space-based ADS-B

- CAAS signed MOU with Aireon on 4 Feb 2015
- CAAS signed service agreement with Aireon on 18 Feb 2016
- Set up local infra-structure in Late 2018
- Received initial data in Feb 2018
  - Coverage include whole of Singapore FIR
- Data verification by Aireon in early 2019
- Integrated and used in ATM system on 15 Jul 2020



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