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INTERNATIONAL CIVIL AVIATION ORGANIZATION

A UN SPECIALIZED AGENCY

Introduction to Automatic Dependent Surveillance - Broadcast

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Content

- What is ADS-B?
- Message Content and Format
- Provisions from ICAO and other bodies

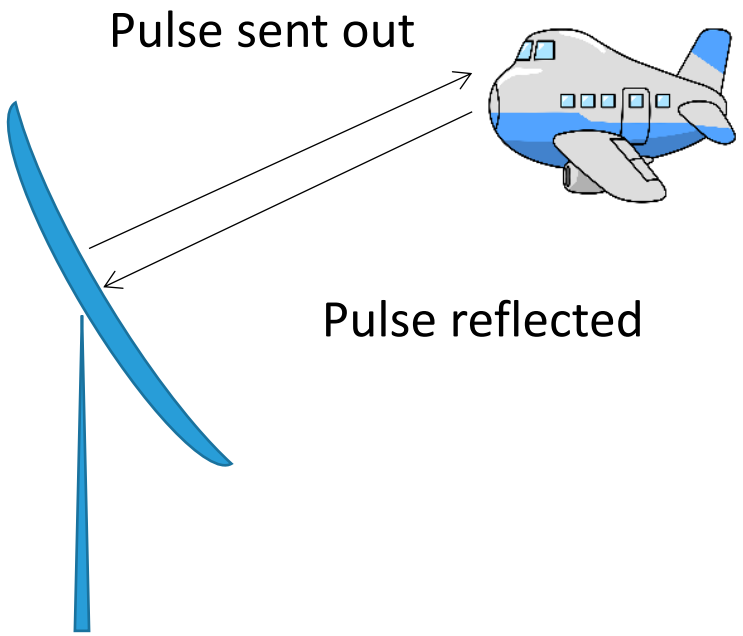
What is ADS-B?

Procedural ATC (Dependent “Surveillance”)

- Pilots report their position
  - Using a voice channel (HF, VHF)
  - Slow, cumbersome
  - Exposed to human error
  - Broadcast : Everyone “on frequency” hears it
- Procedures and standards maintain safety
- A form of dependent surveillance
  - We rely on the pilot/aircraft navigation capability

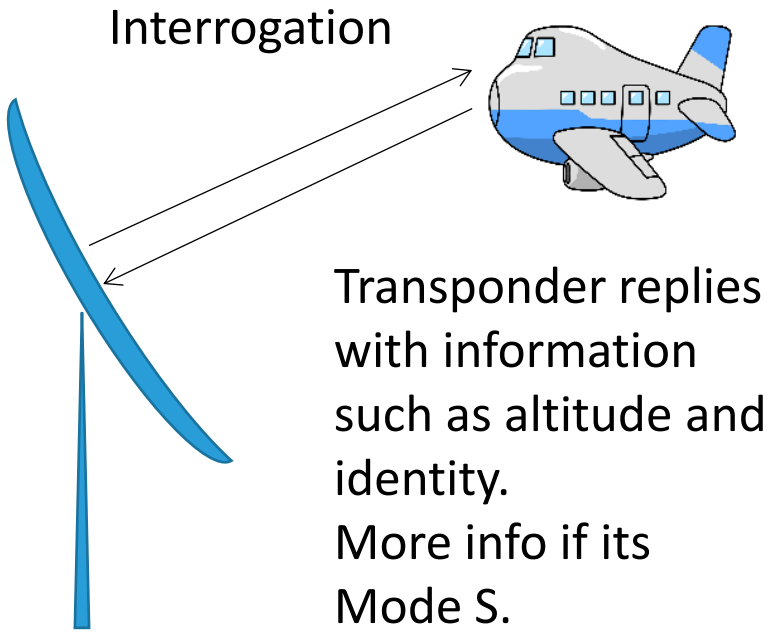
Primary Radar Surveillance (Independent)

- Radar measures position of aircraft
  - in range & azimuth
- Moderate update, accurate
  - Allows smaller separation standards
- Detects non co-operative targets



Secondary Radar Surveillance (Co-operative)

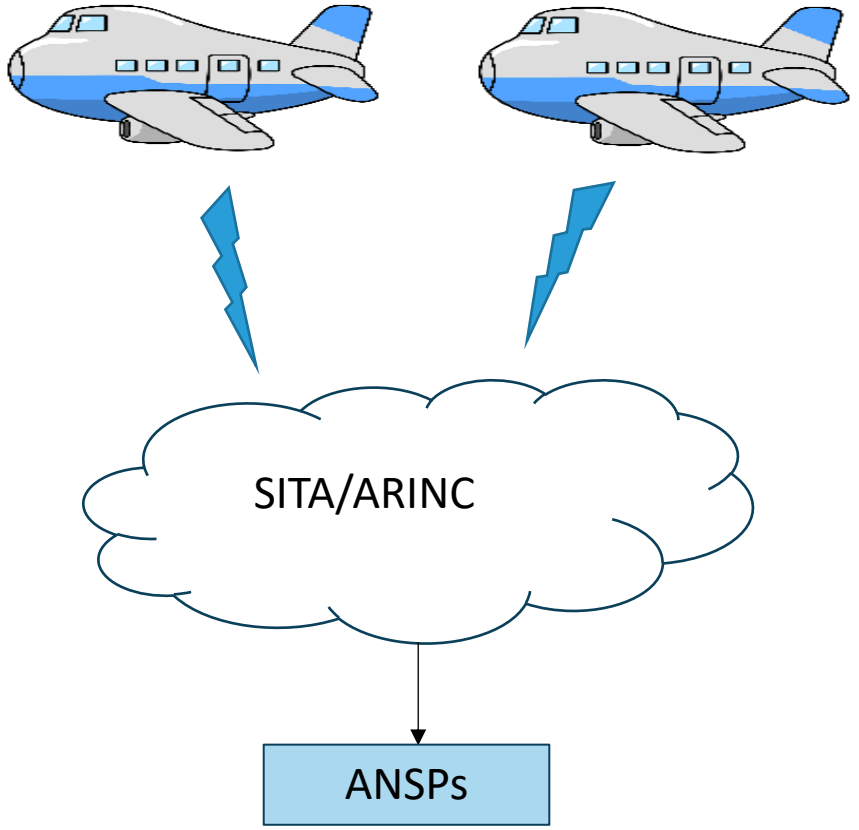
- Radar measures position of aircraft
  - In range & azimuth
  - but relies on cooperation of aircraft to reply
- More accurate
- Allows addition of Safety alerts
- Depends on transponder to downlink information (e.g. altitude)
  - Downlinked information is “dependent” surveillance



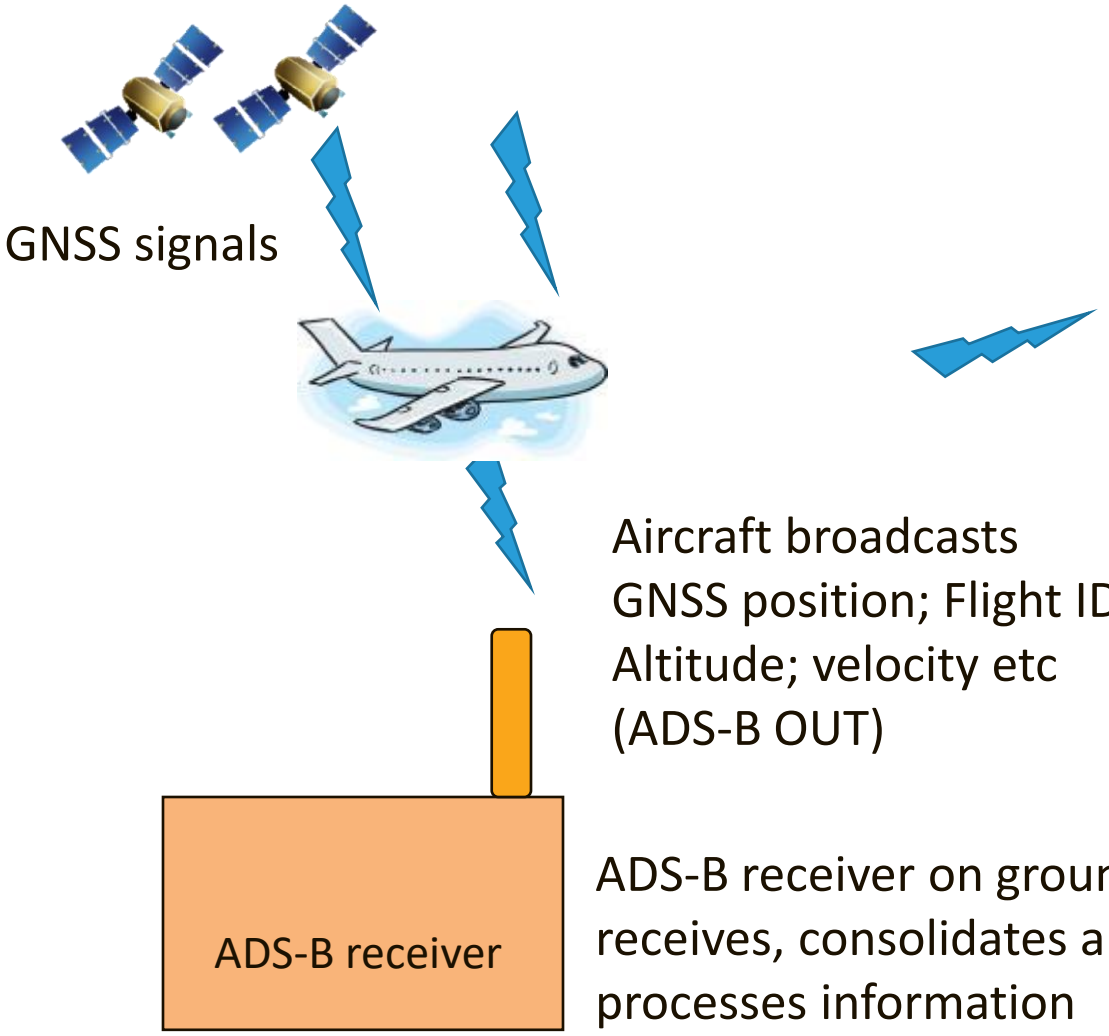
Transponder replies with information such as altitude and identity.
More info if its Mode S.

Automatic Dependent Surveillance - Contract

- FANS1/A Equipment
- Uses satellite and VHF datalinks and 3rd Party service providers
- Provides automatic, accurate routine reports
  - Slow update rate ~ in minutes (eg: every 14 minutes)
  - Supports safety alerts
  - Reports are invisible to other aircraft
- Can enhance procedural separation
- ATC system defines update message rate



Automatic Dependent Surveillance- Broadcast



Automatic Dependent Surveillance- Broadcast

- Automatic - Does not require pilot intervention
- Dependent - Require cooperation from the aircraft e.g. need aircraft to report information accurately
- Surveillance - Provide info on position, identity, altitude etc
- Broadcast - Information is broadcasted to receivers in range

Cost difference

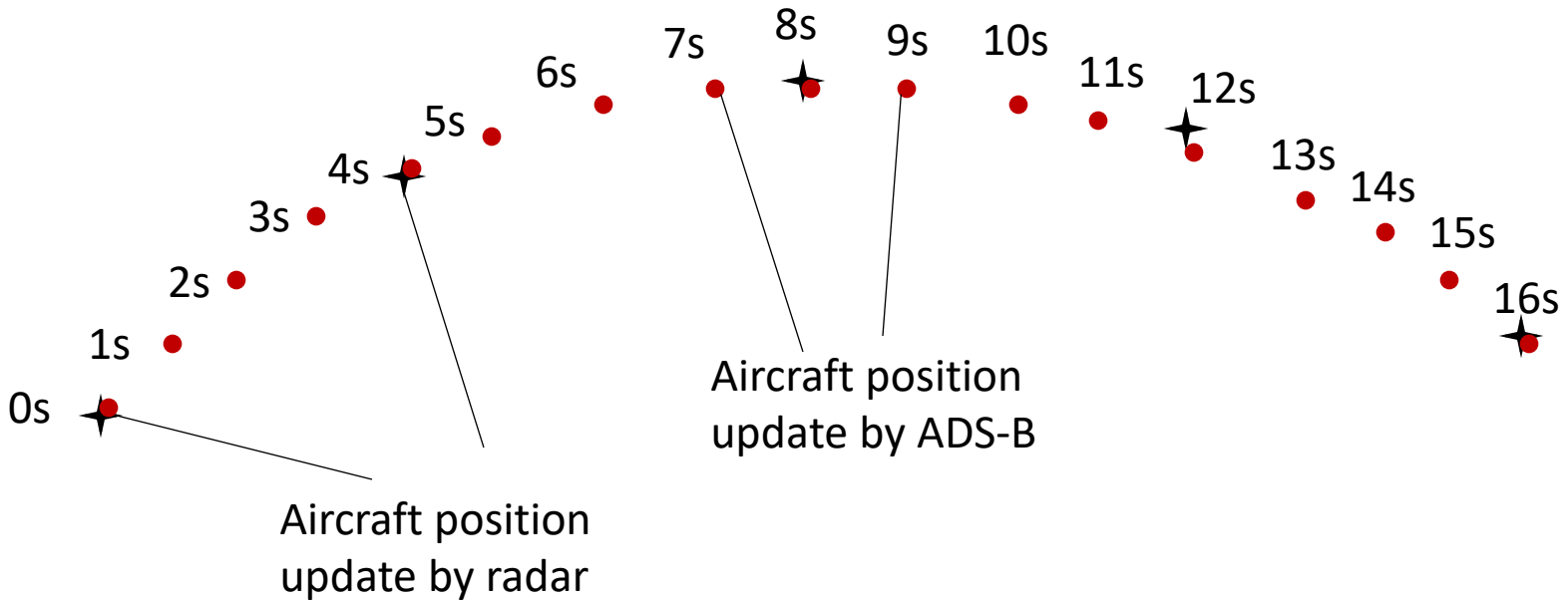
Radar

~US$10,000,000

ADS-B

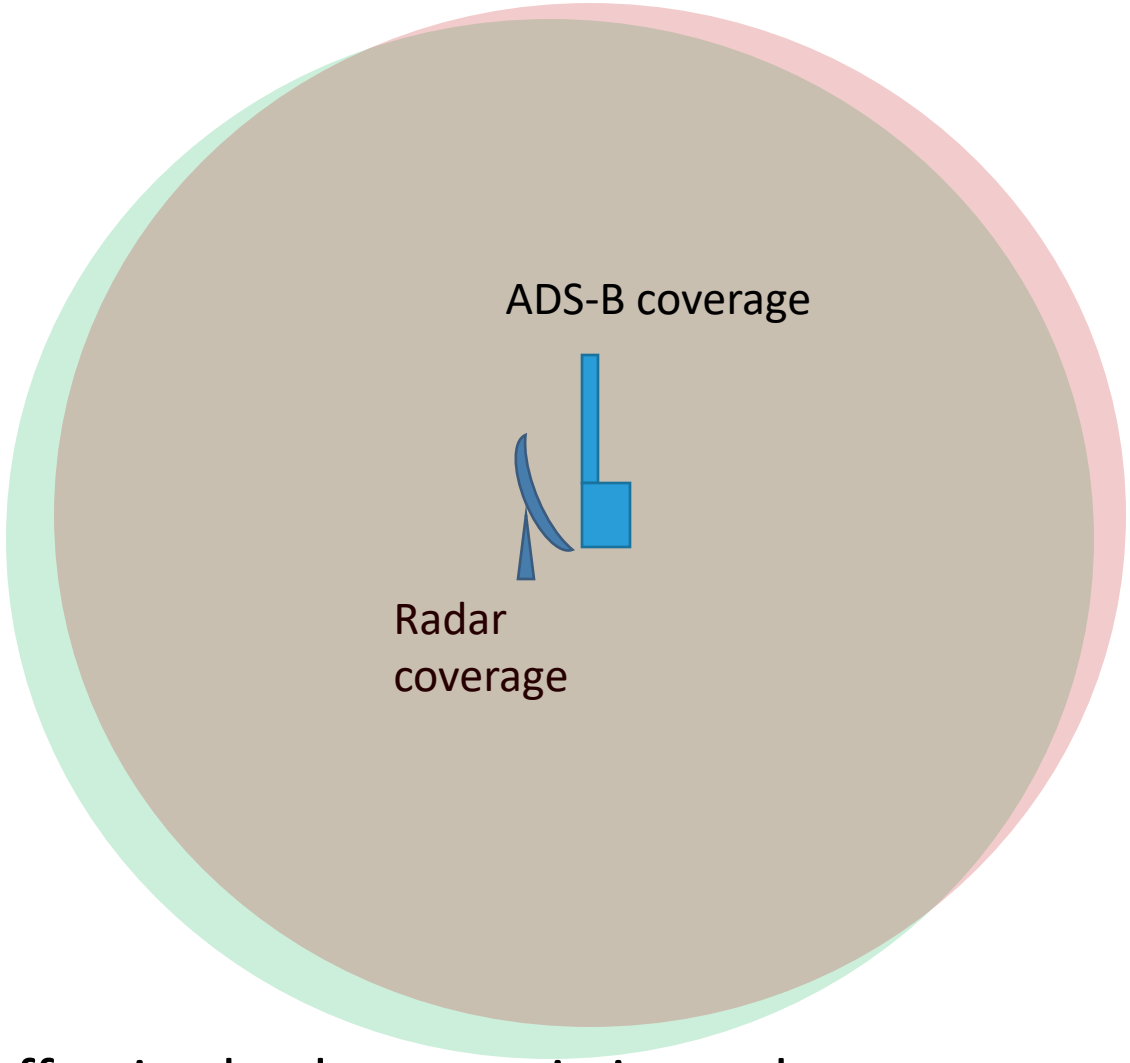
~US$300,000

Benefits of ADS-B (Radar area)



- Increased track accuracy and higher update rate

Benefits of ADS-B (Radar area)

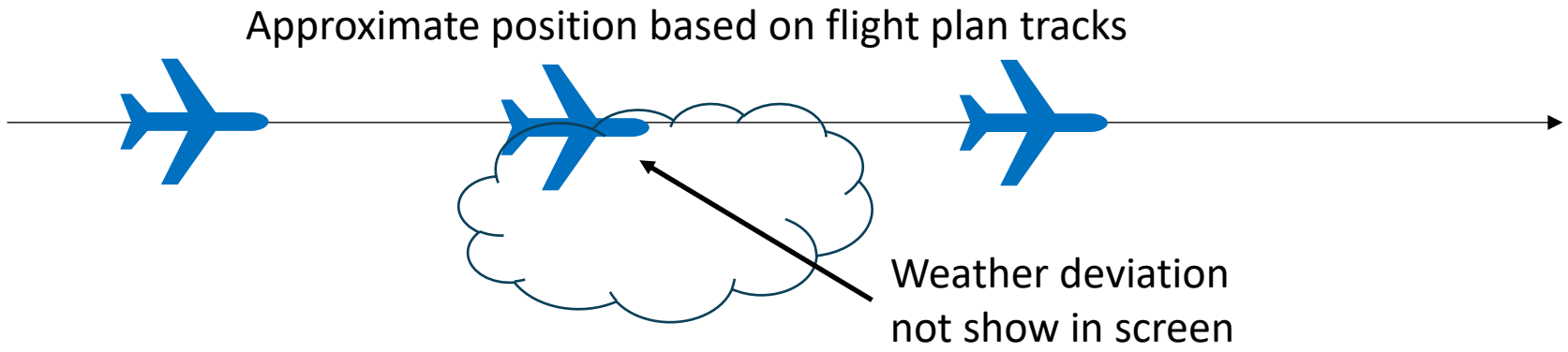


- Cost effective backup to existing radars

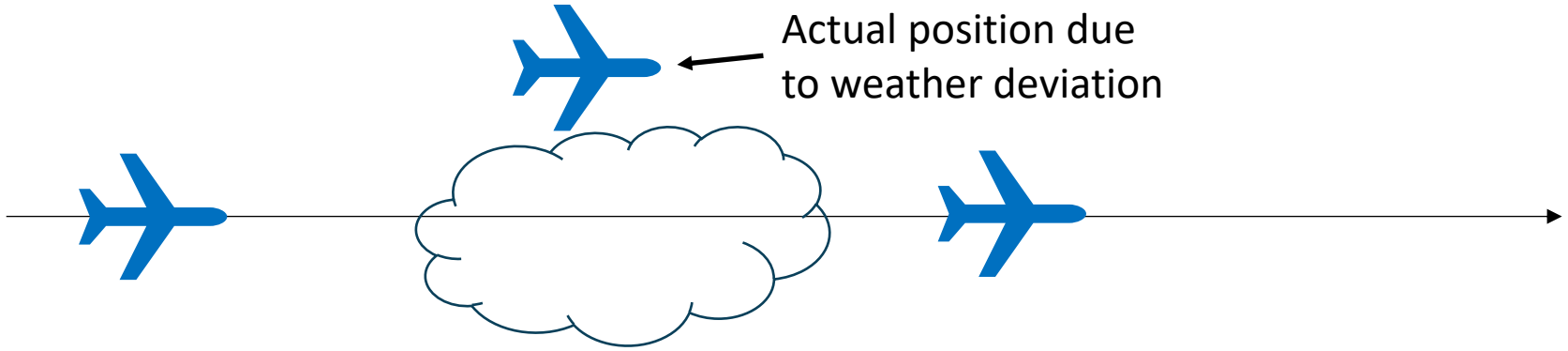
Benefits of ADS-B (Non radar area)

- Improved situational awareness

Without surveillance



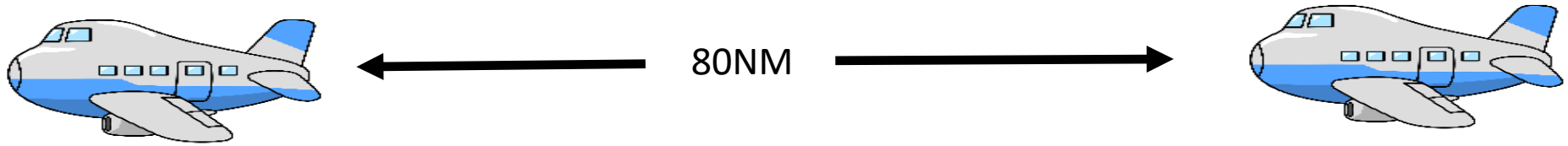
With surveillance



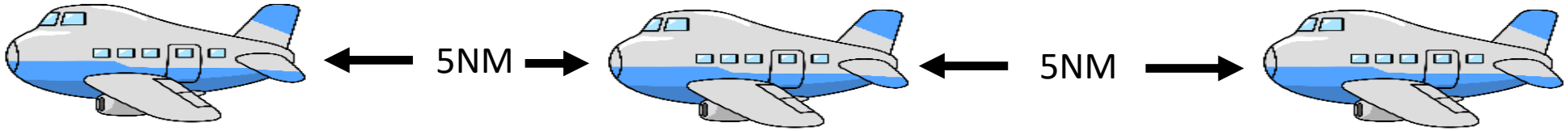
Benefits of ADS-B (Non radar area)

- Reduction in separation

Without surveillance (plus appropriate comms)



With surveillance (plus appropriate comms)



Message Content and Format

Types of ADS-B technology

17

Mode S 1090MHz
Extended Squitter

Universal Access
Transceiver (UAT)

ADS-B
receiver

ADS-B IN equipped
aircraft

Old technology no longer available

VHF Datalink Mode 4
(VDL Mode 4)

Mode S 1090MHz Extended Squitter

- Equipped on almost all large passenger aircraft.
  - Uses 1090 MHz
- Protocol definitions
  - RTCA DO-260 or Eurocae ED-102 (Version 0)
    - Original standard for ADS-B equipped aircraft
  - RTCA DO-260A (Version 1)
    - Standard is now superceded by RTCA DO-260B
  - RTCA DO-260B or Eurocae ED-102A (Version 2)
    - Default on newly delivered aircraft
    - Minimum standard for USA airspace from 2020
  - RTCA DO-260C or Eurocae ED-102B (Version 3)
    - New standard yet to be implemented
    - Can downlink weather information
- Need to ensure that the ADS-B Receiver is able to received in the mentioned formats.

Major differences

	DO-260 (version 0)	DO-260A (version 1)	DO-260B (version 2)
Mode 3/A	Not available	Available as test message	Available
Transponder version	Not available	Available	Available
Accuracy indicator	NACv	NACp, NACv	NACp, NACv
Integrity Indicator	NUCp	NIC, NIC supplement, SIL	NIC, NIC Supplement A/B/C, SIL, SDA
Length/width	Not available	Available	Available
ADS-B in capability indication	Not available	Not available	Available

Upcoming DO-260C/ED102B (Version 3)

- Major additions
  - Indication of Manned/unmanned operations
  - Additional emergency priority and status
  - Extended Velocity and Altitude (for supersonic)
  - Weather data

Common Certification Standards in APAC

- European Aviation Safety Agency - AMC 20-24
  - ED-102/DO-260 (or later)
- Appendix XI of Civil Aviation Order 20.18 of the Civil Aviation Safety Authority of Australia
  - ED-102/DO-260 (or later)
- European Aviation Safety Agency - CS-ACNS-subpart D
  - Must be ED-102A/DO-260B
  - Upcoming revised edition will accept ED-102B/DO-260C
- Federal Aviation Administration – Advisory Circular No: 20-165A (or later editions)
  - Must be ED-102A/DO-260B or ED-102B/DO-260C

Typical ADS-B messages from aircraft (1090ES)

- Position message (every 0.5s)
  - Position integrity, barometric altitude, position in lat/lon, surveillance status (emergency or change in Mode A or SPI)
- Velocity message (every 0.5s)
  - Velocity integrity, diff between baro and geo altitude, velocity
- Aircraft identification message (every 5s)
  - Flight ID and the type of aircraft (e.g. large aircraft vs surface vehicles)
- Others
  - Extended Squitter Aircraft Status Message
    - Type of emergency
    - Active resolution advisory in DO-260B and DO-260C
  - Target State and Status message
    - target altitude, selected heading etc
  - Aircraft Operational Status Message
    - Indication of MOPS version in DO-260A, DO-260B and DO-260C
  - Aircraft reported weather messages (DO-260C)
  - Pilot reported weather messages (DO-260C)
  - High Velocity/Altitude message (DO-260C)

Universal Access Transceiver

- Requires a dedicated transceiver in each aircraft
  - Normally used by smaller aircraft
  - Uses the 978MHz
  - Mainly used in USA
- Protocol definitions
  - RTCA DO-282
  - RTCA DO-282A
  - RTCA DO-282B
    - Minimum standard for USA airspace from 2020 where UAT is used

Data format for transmission to ATC system

ADS-B receiver

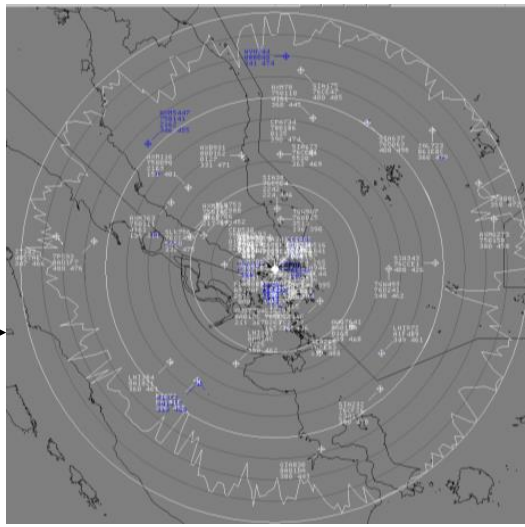
ADS-B receiver

ADS-B reports (Eurocontrol ASTERIX CAT 21)

ADS-B reports (Eurocontrol ASTERIX CAT 21)

ATC System

To display



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Eurocontrol ASTERIX CAT 21

- ASTERIX CAT 21
  - Several Editions available
  - Limited backward compatibility

- Editions must be compatible
  - Both system (ADS-B receiver and ATC system) must use the compatible edition

- Document is available free-of-charge at the EUROCONTROL website

ASTERIX CAT 21 (part 1)

- CAT 21 edition 0.23
  - Does not have mode A
  - Does not indicate MOPS version
- CAT 21 edition 0.26
  - This edition onwards contain mode A
- CAT 21 edition 1.0 to 1.8
  - Contains DO-260A enhancements (e.g. SIL, length/width for surface)
  - Changes from editions 1.0 to 1.6 are editorial
  - Introduced independent position check bit at edition 1.7.

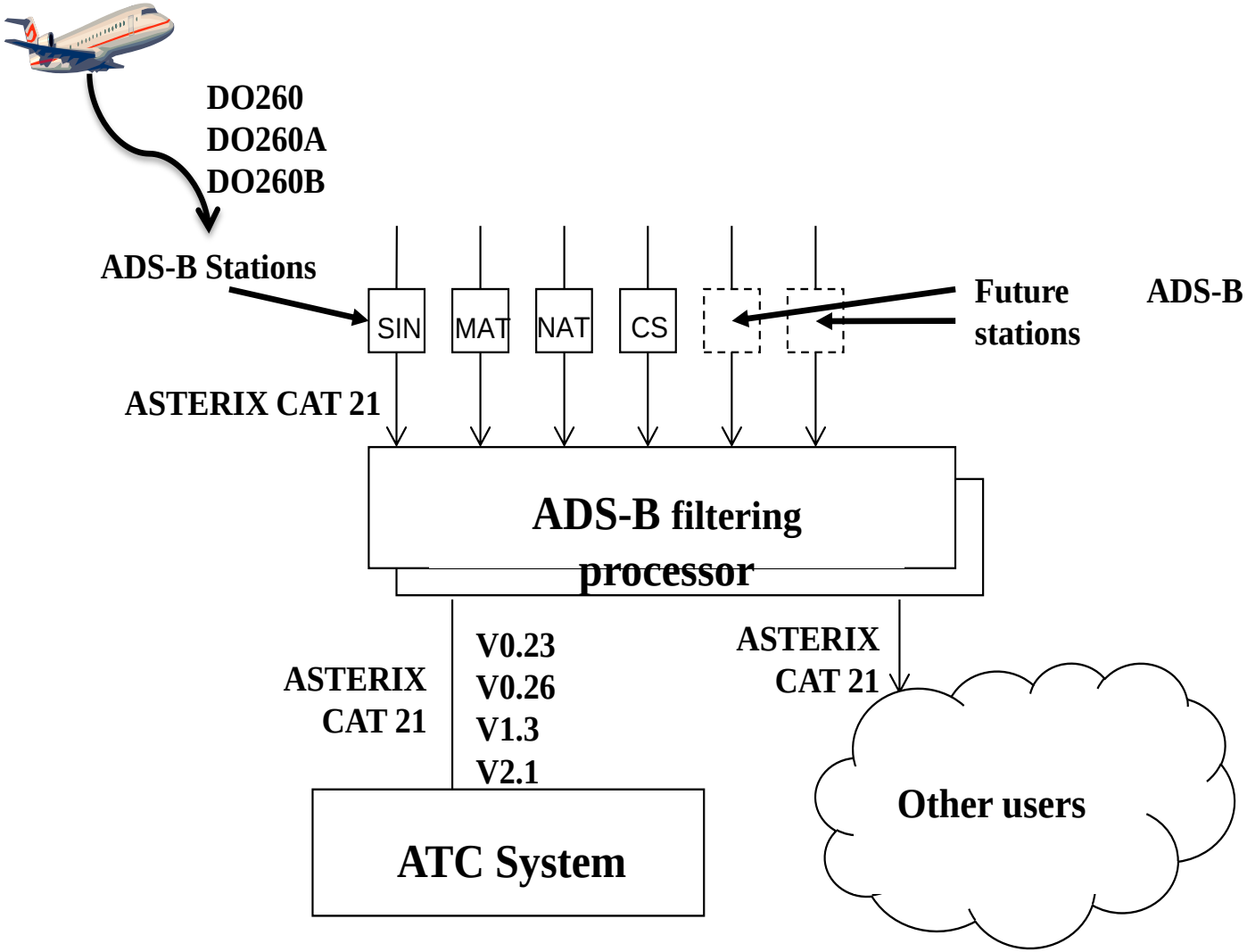
ASTERIX CAT 21 (part 2)

- CAT 21 edition 2.1
  - Contains DO-260B enhancements (e.g. SIL-sup, SDA)
  - Backwards compatible with edition 1.x
  - Additional information in the optional Reserved Expansion Field (e.g. selected heading, antenna offset, barometric pressure setting)
- CAT 21 editions 2.2
  - Amend the format of ‘length/width’
  - Not backwards compatible with edition 2.1
- CAT 21 editions 2.3 to 2.4
  - Includes a flag to indicate black-list/white-list check failure
  - Changes from editions 2.3 to 2.5 are mainly clarifications
- CAT 21 editions 2.5
  - Edition 2.5 include the stating version 3 (i.e. DO-260C)

Upcoming ASTERIX Category for ADS-B

- CAT 53
  - Full Implementation of ADS-B Version 3
  - Completely new Development, already started
  - Performed as a joint activity with EUROCAE WG-51/SG-4 (ED-129/ED-142)
  - Target date: not before middle of 2024

Managing different inputs and outputs (Singapore's example)



Typical Information in the ADS-B reports from receiver

- Time stamp
  - Time which the position information reaches the ADS-B receiver
- Aircraft address
  - The 24 bit address assigned to the aircraft (e.g. hex 76ABCD) (most important)
- Aircraft ID
  - Typically the call-sign of the aircraft (e.g. SIA0123)
- Aircraft position
  - Position in Lat, Lon as calculated by the aircraft's positioning system
- Barometric altitude
  - Aircraft height as measured by barometer assuming standard atmosphere
- Geometric altitude
  - Aircraft height as measured by aircraft's positioning system
- Velocity
  - Velocity reported by aircraft
- Navigation Uncertainty Category (NUCp in DO-260), Navigation Integrity category (NIC in DO-260A and above)
  - Position integrity measurement (e.g. NUCp = 5 means containment 0.5NM with 99.999% probability)

Provisions from ICAO and other bodies

Provisions from ICAO

- SARPs and PANS
  - Annex 10 Vol IV - SSR and ACAS (ADS-B extended squitter)
  - Annex 10 Vol I GNSS
  - Annex 10 Vol III Communications systems (24 bit address)
  - Annex 2 Rules of the Air
  - Annex 11 Air Traffic Services
  - Doc 4444 PANS-ATM
  - Doc 8168 PANS-OPS
- Technical Requirements
  - Doc 9871 Technical Provisions for Mode S Services and Extended Squitter
- Guidance Materials
  - Doc 9924 Aeronautical Surveillance Manual
  - Doc 9994 Manual on Airborne Surveillance Applications
  - Cir 326 Assessment of ADS-B and MLAT Sur to support ATS and guidelines for implementation
  - Guidance on Performance Based Surveillance (RSUR) – under development

Provisions from other bodies

- Eurocae / RTCA
  - ED-102/DO-260 (and later updates)
  - ED-126/DO-303 SPIR for ADS-B-NRA Applications
  - ED-161/DO-318 SPIR for ADS-B-RAD Applications
  - ED-129C Technical specification for a 1090 MHz extended ADS-B Ground Station
  - ED-261 SPR for a Generic Surveillance System

- EUROCONTROL
  - ASTERIX CAT 21
  - ASTERIC CAT 33 (developed by FAA)
  - ASTERIX CAT 53 – under development
  - EUROCONTROL Specification for ATM Surveillance System performance (ESASSP)

Thank You!

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