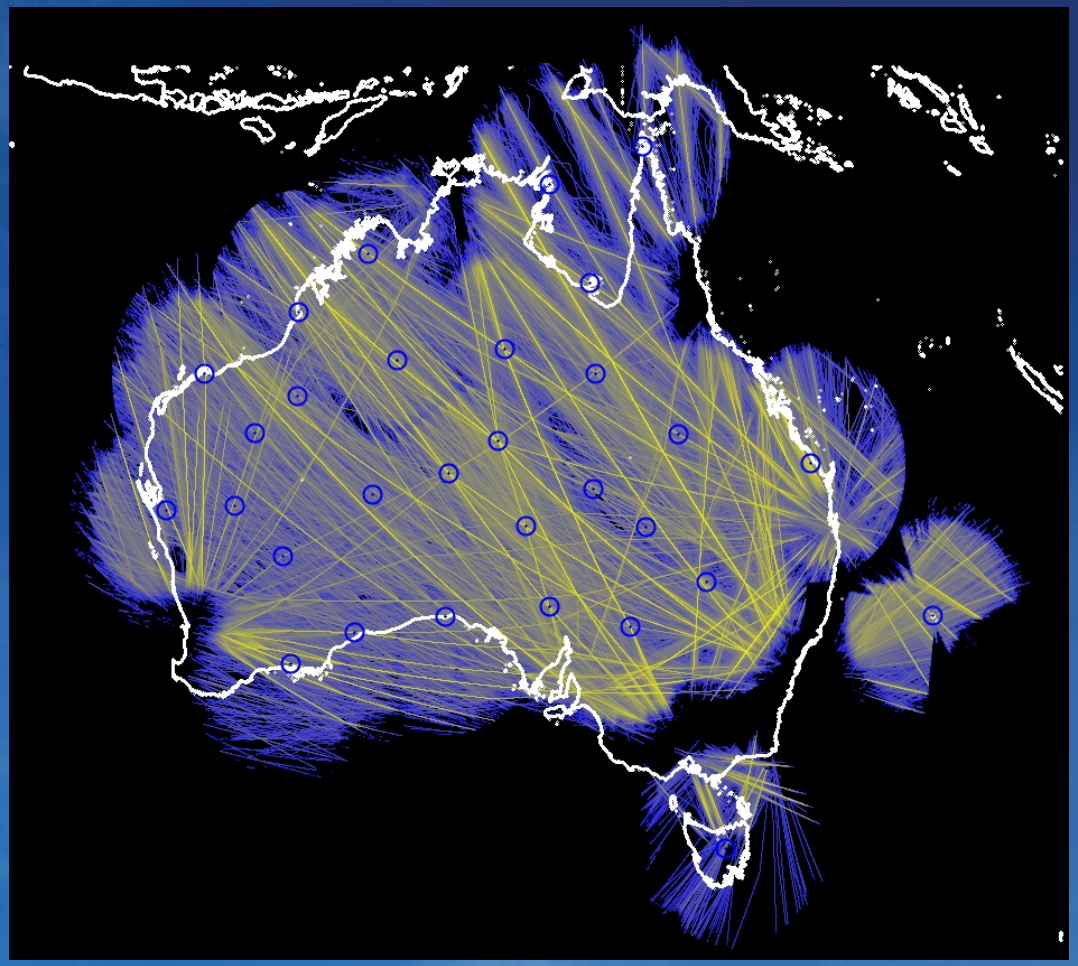
airservices

ADS-B Introduction



Greg Dunstone

Surveillance Program Lead, Airservices Australia

SURVEILLANCE Basics

Primary and Secondary radar

Why do we need Surveillance?

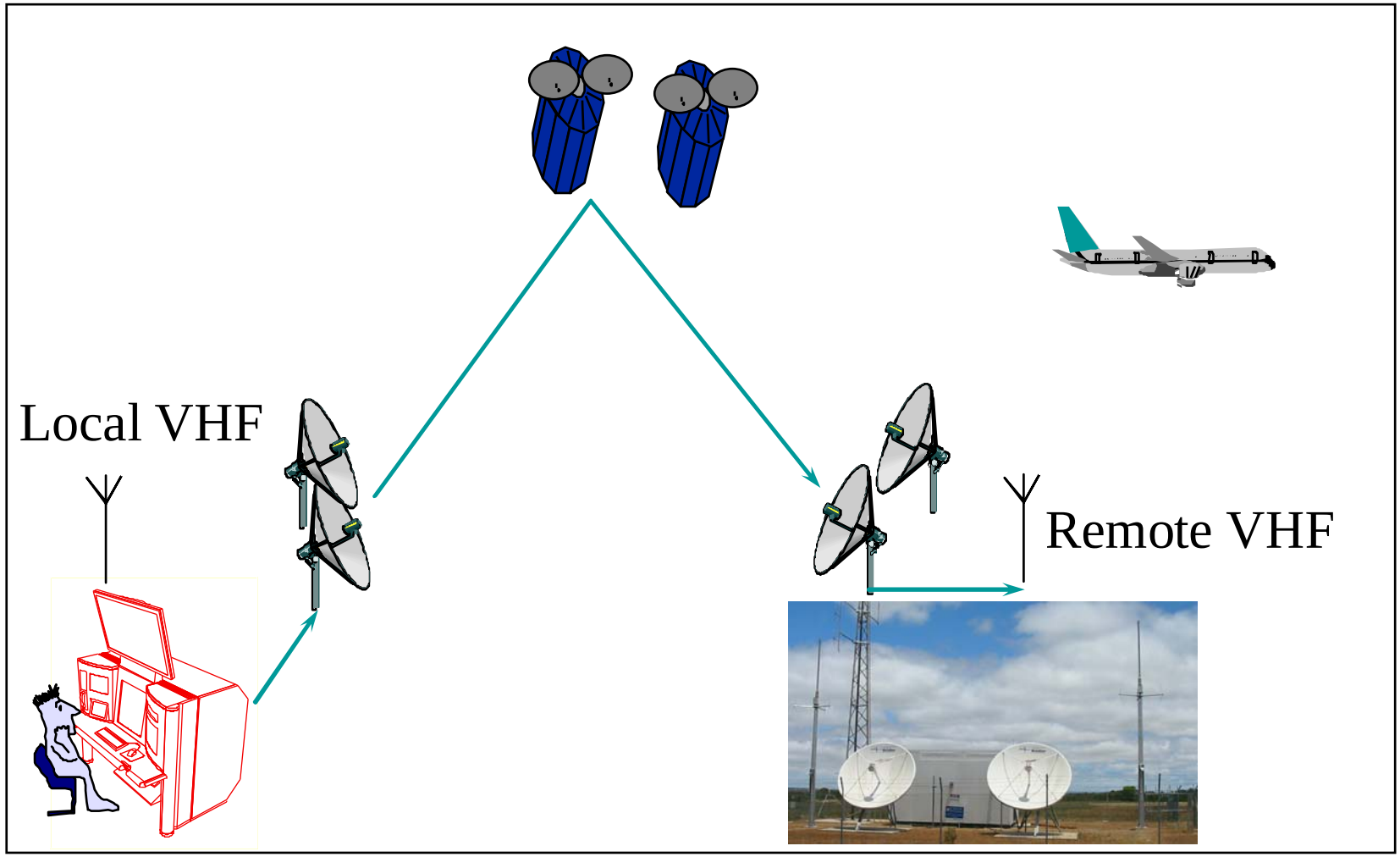
airservices

Why surveillance?

- Improved safety
  - ✓ Reduced separation between aircraft
  - ✓ Automated safety alerts for ATC
  - ✓ Situational awareness for ATC
  - ✓ Improved Search & Rescue
  - ✓ Less transactional work for ATC/Pilots

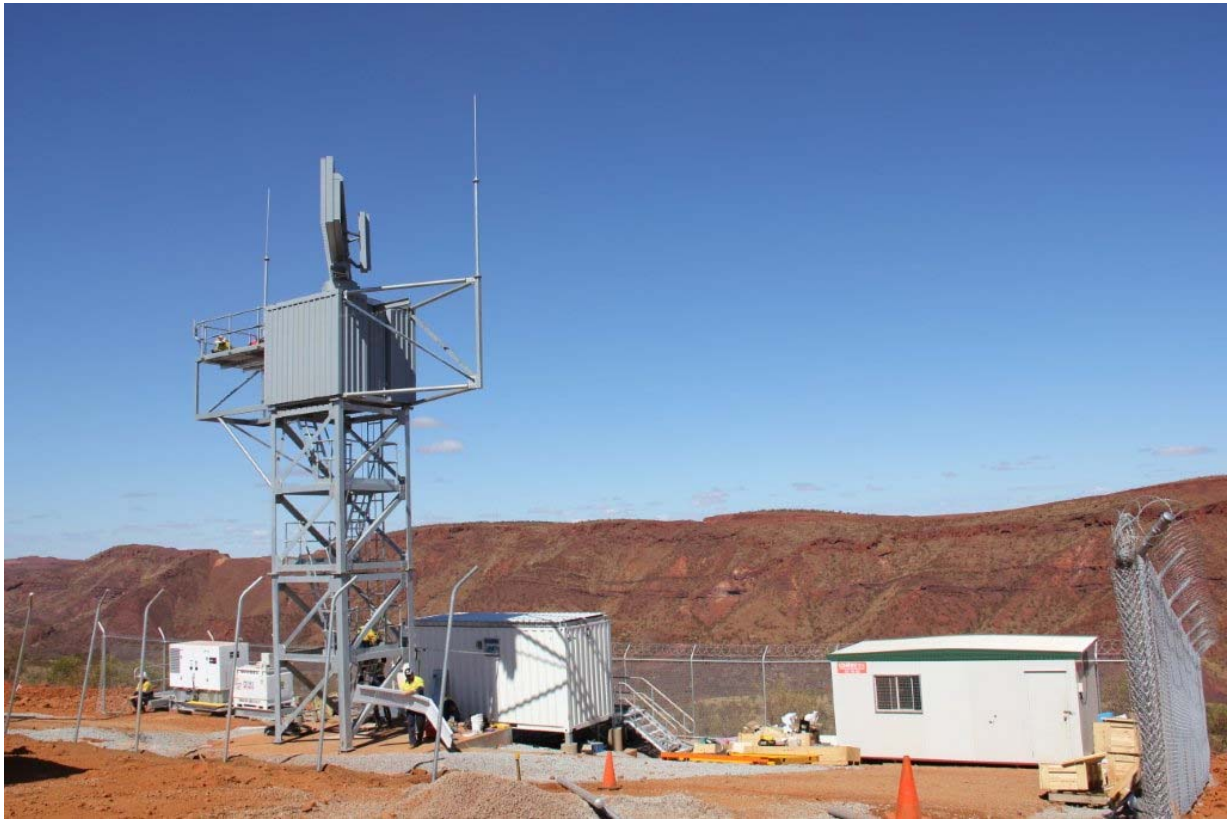
- Improved efficiency for users
  - ✓Reduced & more flexible separation standards
  - ✓More clearances to requested route/level
  - ✓Reduced stepped climb/descent
  - ✓Increased flexibility in poor weather
  - ✓Less delay
  - ✓Lower pilot & ATC workload
  - ✓Reduced fuel burn & operating time
    - Reduced environmental impact

Surveillance benefit limited without Voice communication



To support a radar site?

- A site
- Power
- Communications links
- Reliability
  - Typically everything duplicated
- Accuracy
- Remote Monitoring & control



ADS-B

AUTOMATIC
DEPENDENT
SURVEILLANCE
- BROADCAST

ADS-B - What is it ?

- Aircraft determines position using GPS
- Broadcasts position, identity, altitude and velocity **(ADS-B out)**
- Ground stations receive broadcasts and relay information to ATC
- Other aircraft receive broadcasts & display to pilot **(ADS-B in)**

ADS-B ground stations are simple and economical

ADS-B
~ $100K-$400K USD

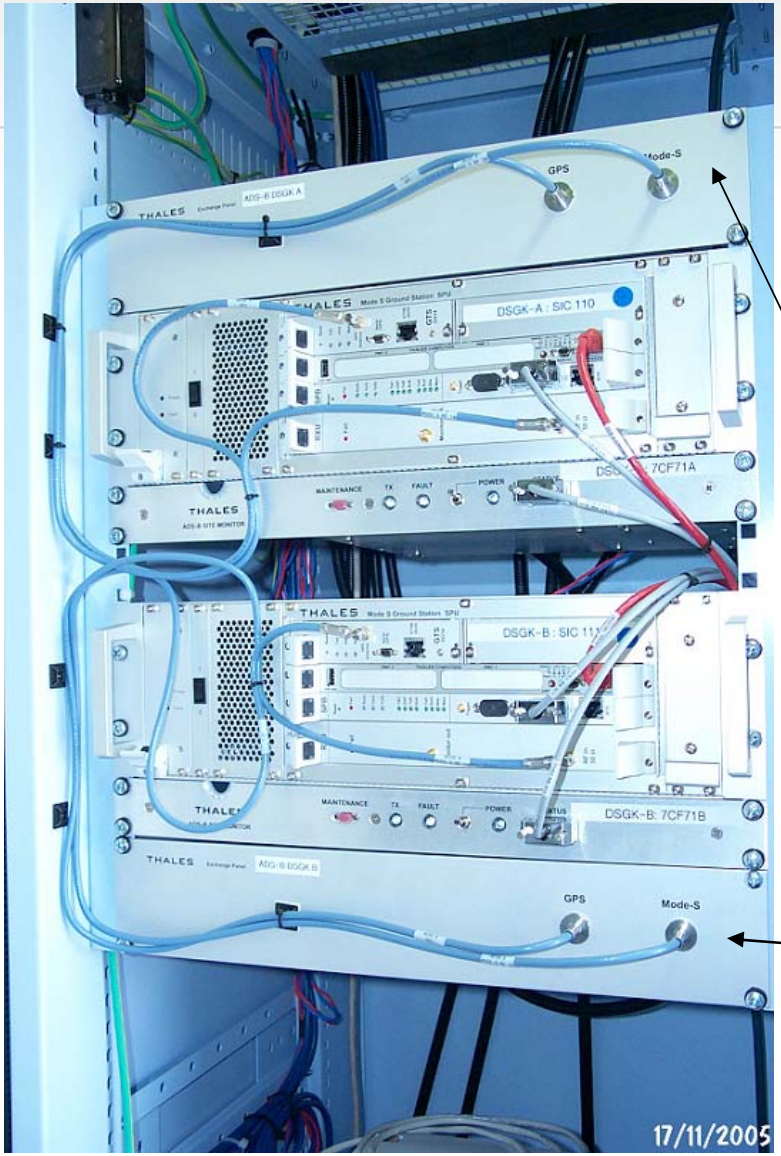
Cost Comparison

Maintenance
Power
Site space
Building
Road
Environmental
Rotating machinery

RADAR
~ $1M - $4M USD

Can be installed @ Existing VHF/Navaid site

- ADS-B antennas
- At a NDB/VHF site
- Power, Lease, Communications elements exist

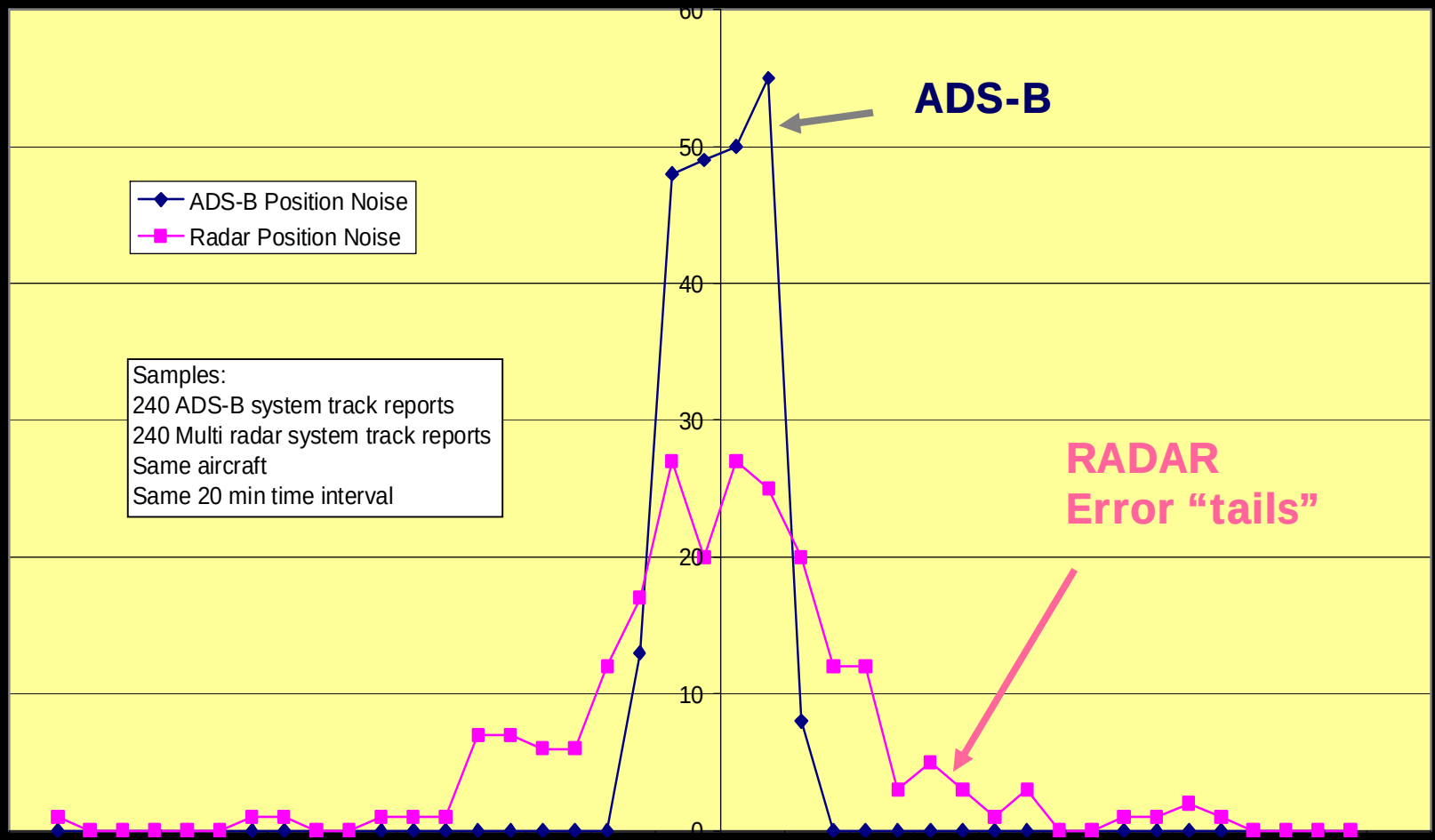


ADS-B Ground Station Equipment

- Installed
- Duplicated
- With Site monitors

TESTING : Radar compared to ADS-B

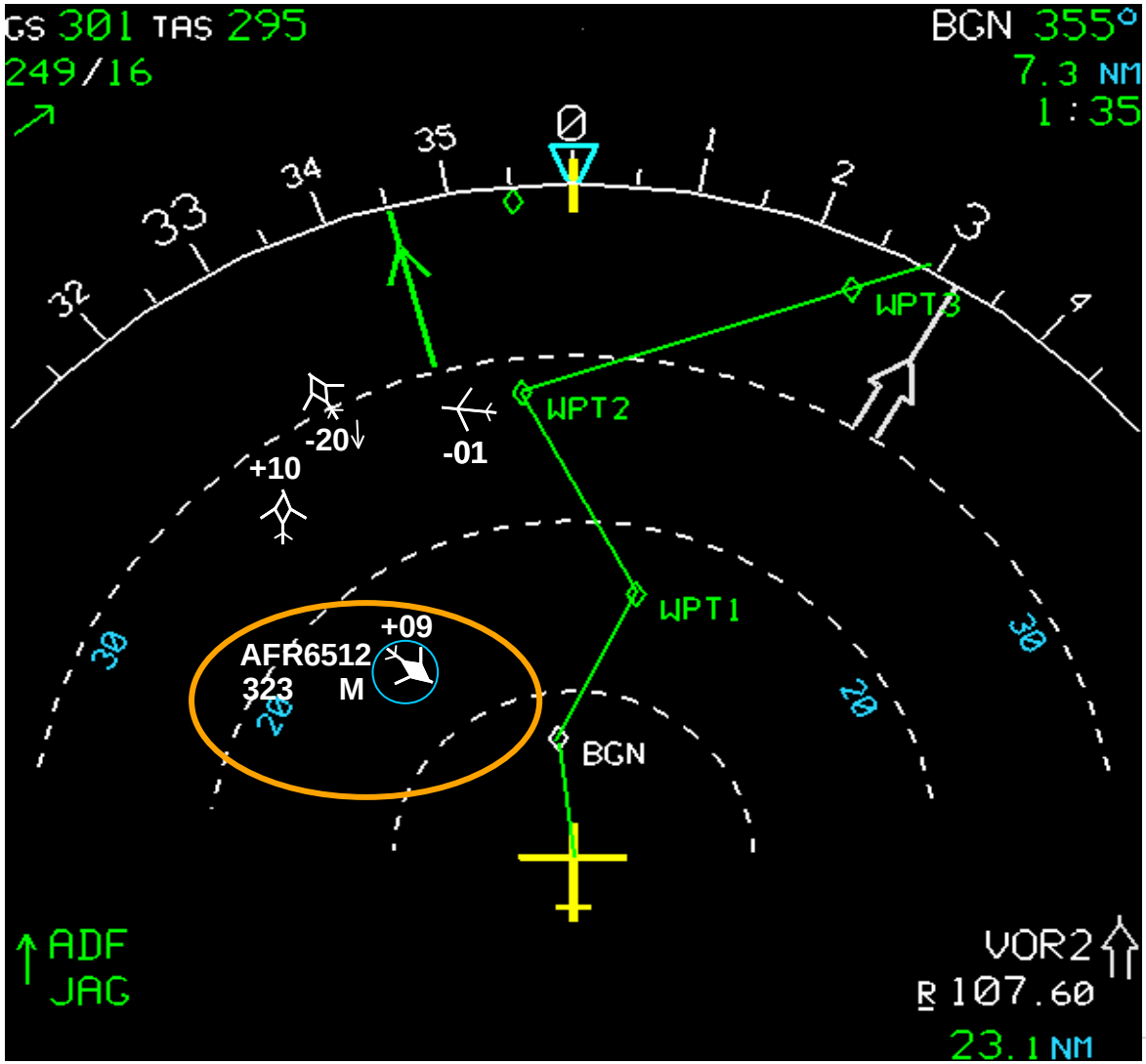
Radar & ADS-B
Noise distribution



Burnett Basin Trial Experience in 2002

- Coverage good
- Accuracy good
- High update rate
- High fidelity velocity vector
- Includes Flight ID

We know ADS-B provides lower cost surveillance



plus provides base for ADS-B IN

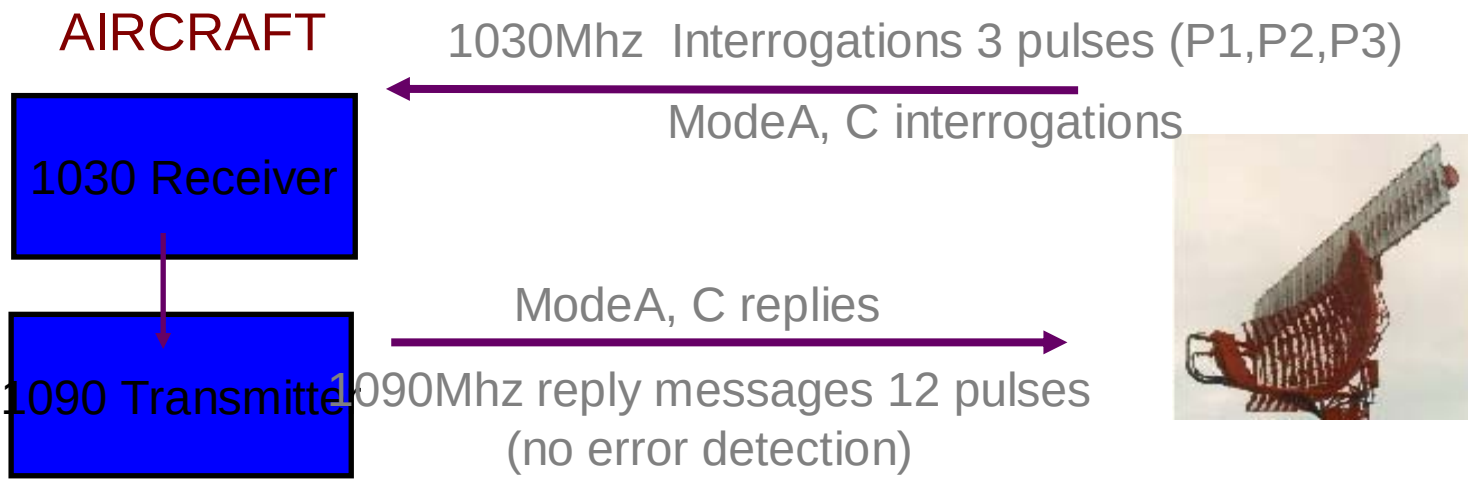
EUROCONTROL

Participation in flight trials

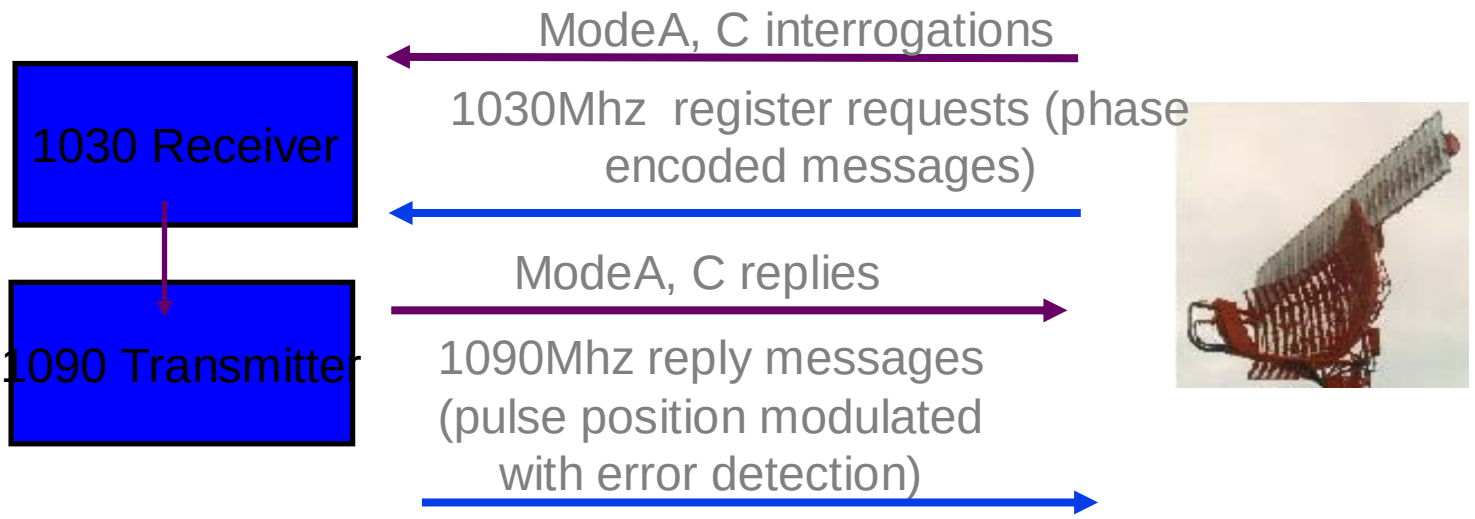
They have already selected ATSAW…

How does it work ?
(Relationship to Mode S)

SSR background



MODE S background



Readout :
“Registers”

TCAS background

1030Mhz Interrogations 3 pulses

1030 Receiver

1030Mhz register requests (phase encoded messages)

Transmit DF11

1090Mhz reply pulses

1090 Transmitter

1090Mhz reply messages (pulse position modulated with error detection)

Receive ModeC replies

Receive DF11

Receive DF0

1090 Receiver

TCAS LOGIC & Display

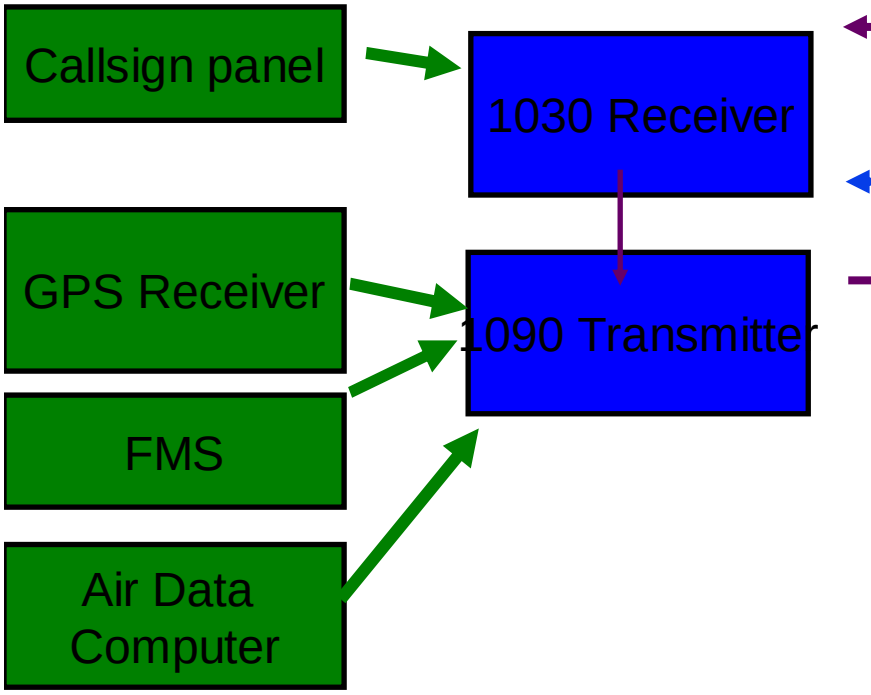
1030 Transmitter

Mode C interrogate

Mode S interrogate (UF0)

Enhanced & Elementary Surveillance

DATA to FILL the REGISTERS



1030Mhz Interrogations 3 pulses

1030Mhz register requests (phase encoded messages)

1090Mhz reply pulses

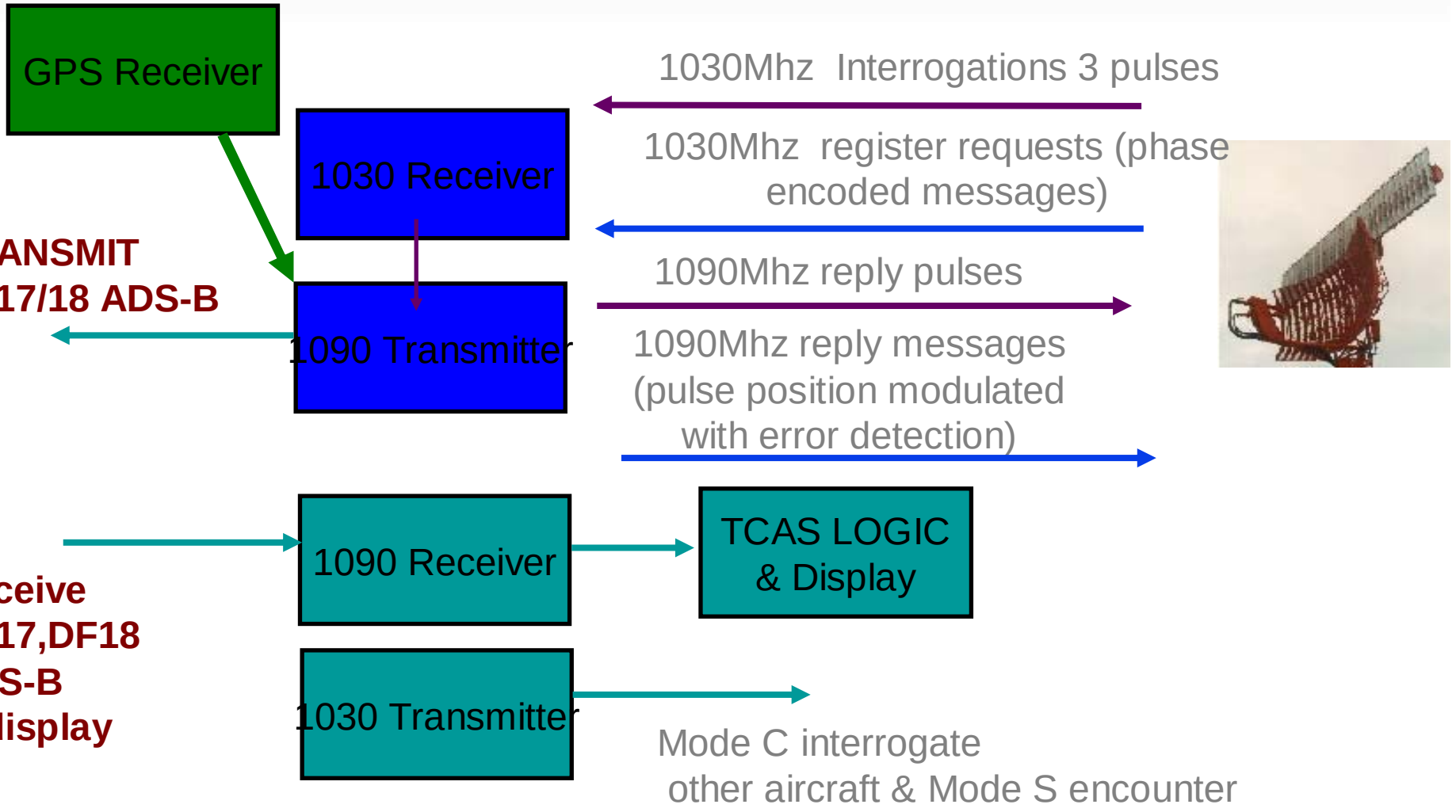
1090Mhz reply messages (pulse position modulated with error detection)

Readout :
Callsign
Bank angle
Selected level
Airspeed
Heading

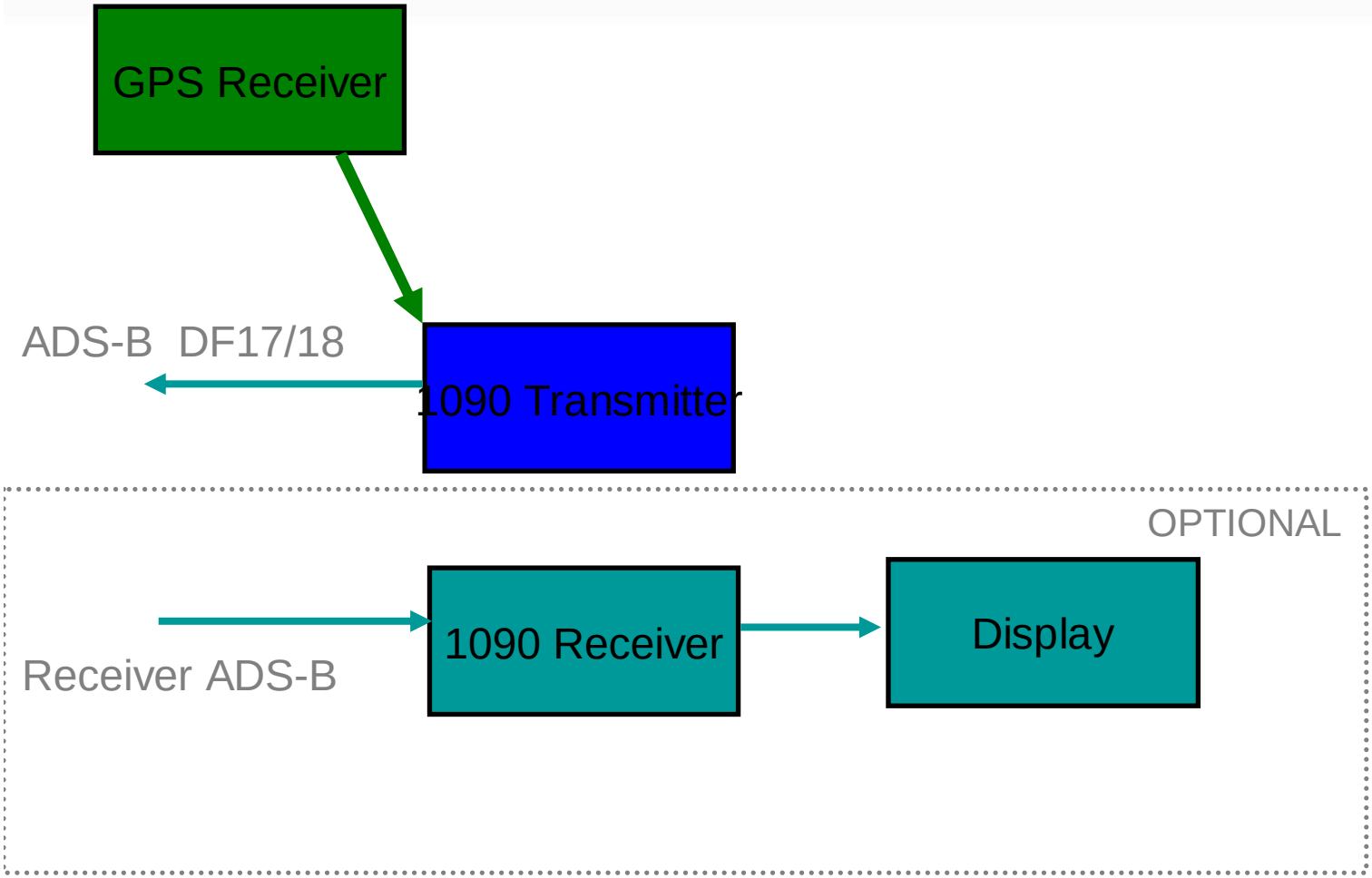
Speed

450
400
350
300
250
200
150
100
50
0
31:12.0
45:36.0
00:00.0
14:24.0
28:48.0
43:12.0
57:36.0
12:00.0
Radar_Ground Speed
Ground_Speed
Tru Airspeed
Indicated Airspeed

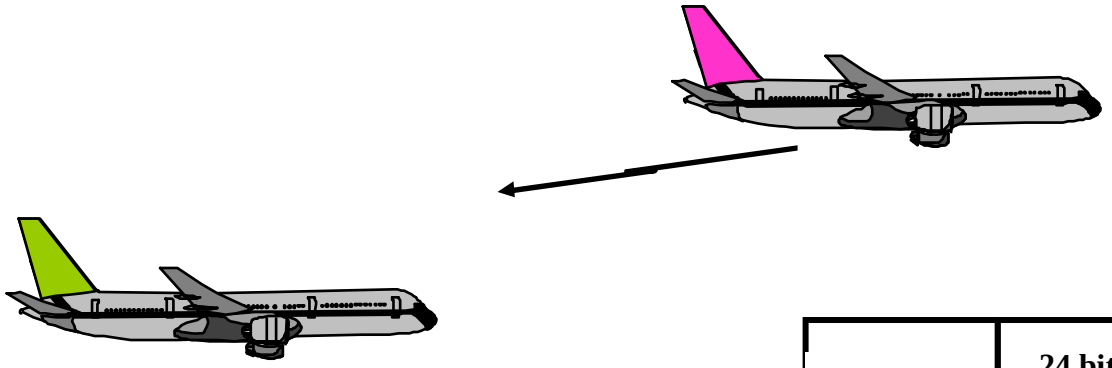
ADS-B background



ADS-B simplified



Mode S Transponder & ADS-B



TCAS

CONTROL	24 bit AIRCRAFT ADDRESS	PARITY

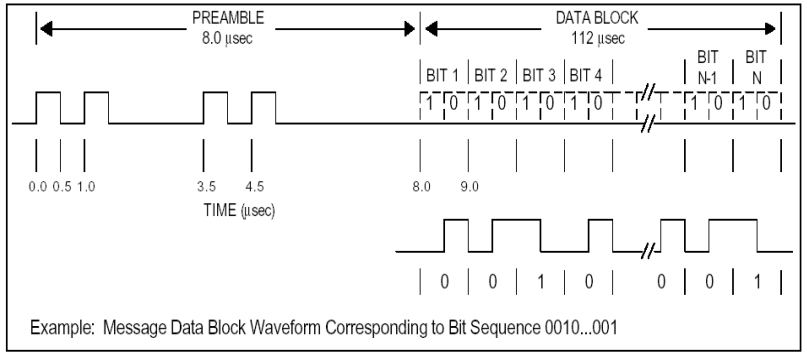
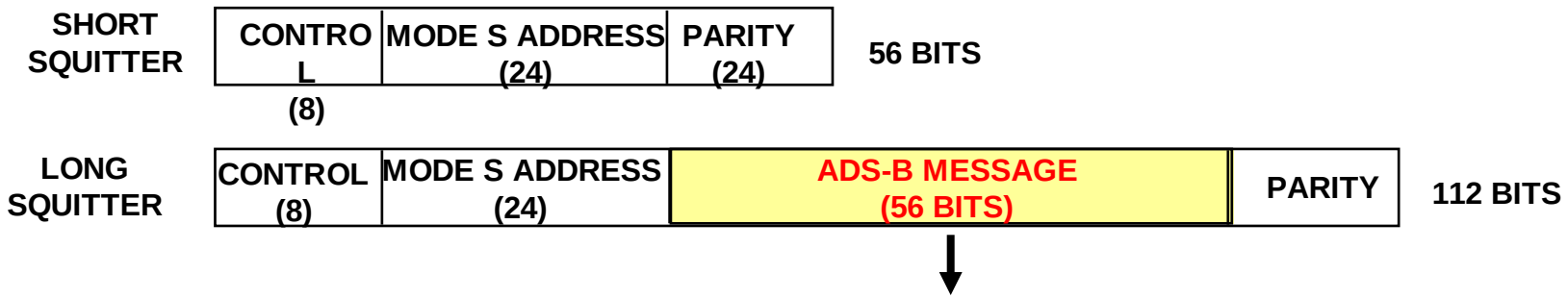


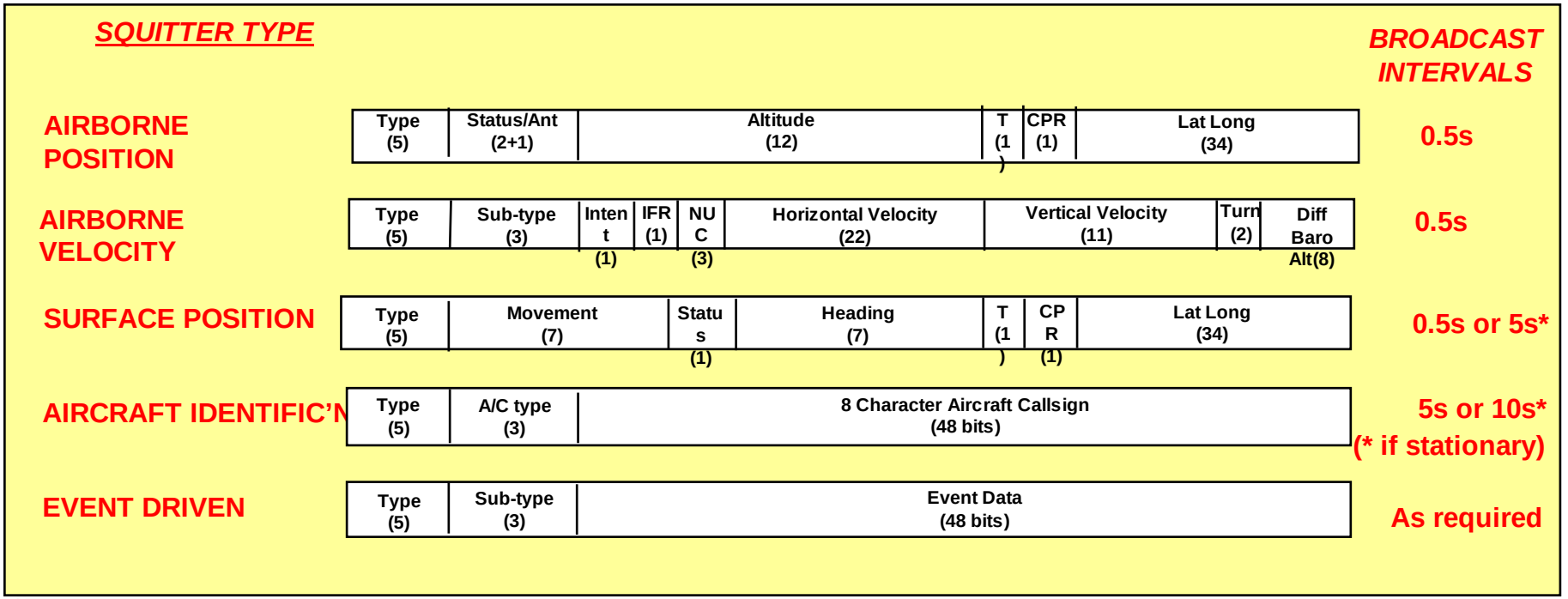
Figure 2-1: ADS-B Message Transmission Waveform

ADS-B

CONTROL	24 bit AIRCRAFT ADDRESS	ADS-B MESSAGE 56 Bits	PARITY

MODE S EXTENDED SQUITTER





What avionics are needed?

3 major elements
- GPS
- Transponder
- Callsign entry

AIRCRAFT ID : CALLSIGN

POSITION & INTEGRITY

GPS/ MMR

ATC TRANSPONDER

ALTITUDE

SA Aware not required for aircraft manufactured before Dec 2012

Airframe dependent

May have some elements already
- Software upgrade?

Transponder
- ADS-B and Radar

Multiple solutions
- Multiple vendors
- Different prices

HPL / HFOM (Position Quality)

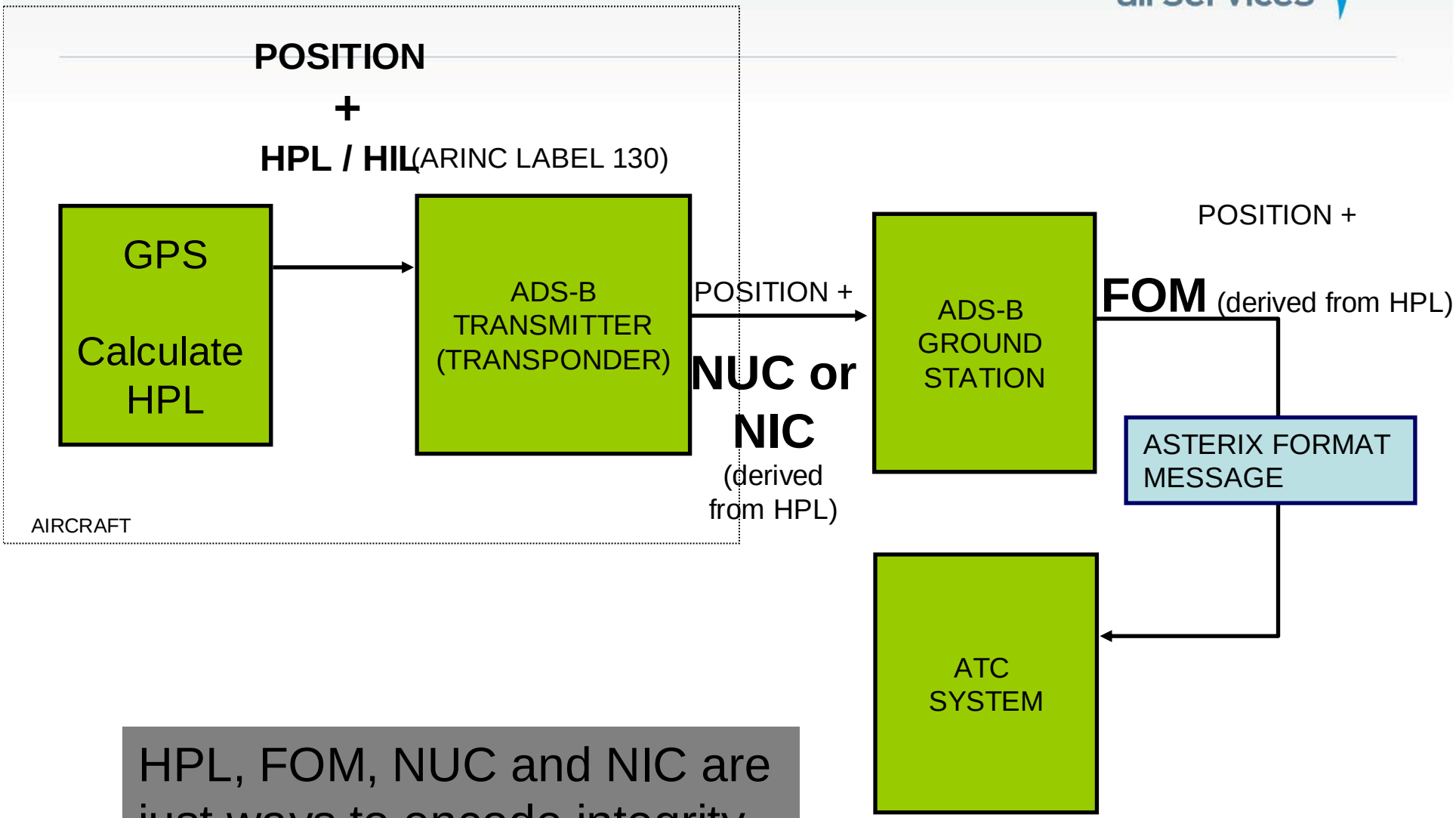
HFOM : Accuracy measure assuming that all satellites are operating correctly

HPL : Integrity measure.
Positional data within this limit with high degree of certainty.

- Even if a satellite gives false range data.

- Based on GPS receiver ability to detect satellite false range data given
  - Satellite geometry
  - RAIM algorithm capability
  - Assumption SA on/off
  - WAAS signal received (not applicable in Australia)

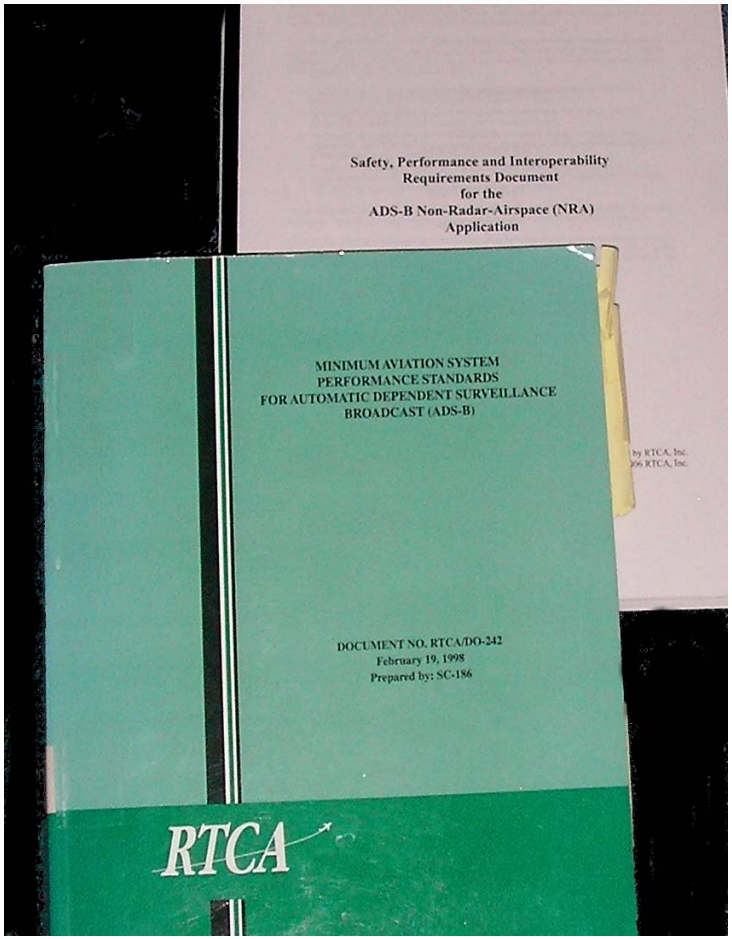
Position & Integrity data



HPL, FOM, NUC and NIC are just ways to encode integrity

Standards

Standards Exist



Eg: RTCA DO303
"ADS-B in Non-Radar Airspace – NRA"

Standards for Global interoperability

DO303 – NRA

DO318 – RAD

Led to AMC20-24 certification

Standards for Mode S

USA	EUROPE
ICAO → Signals in Space • Annex 10 SARPS Amend 77	
Service • NRA : RTCA DO303 • RAD : RTCA DO318	**Service** • NRA : ED126 • RAD : ED161
AVIONICS & TEST STANDARDS • RTCA - ADS-B MOPS 1090 DO260 - DO260A - DO260B	AVIONICS & TEST STANDARDS • EUROCAE - ED102 - ED102A
FORM/FIT STANDARDS • AEEC - ARINC 718A	**FORM/FIT STANDARDS** • EUROCAE - ED86
REGULATOR FAA -TSO C166B	REGULATOR EASA - AMC20-24 - NPA 2012-19 / CS-ACNS (DO260B)

8.6.2.2 ADS-B IDENTIFICATION PROCEDURES

Where ADS-B is used for identification, aircraft may be identified by one or more of the following procedures:

a) direct recognition of the aircraft identification in an ADS-B label;

b) transfer of ADS-B identification (see 8.6.3);

c) observation of compliance with an instruction to TRANSMIT ADS-B IDENT.

8.7.2.5 Separation based on the use of ADS-B position symbols and SSR responses shall be applied so that the distance between the centre of the ADS-B position symbol and the nearest edge of the SSR response (or the centre, when authorized by the appropriate ATS authority) is never less than a prescribed minimum.

Note 3.— Guidance material pertaining to use of ADS-B and to system performance is contained in the Assessment of ADS-B to Support Air Traffic Services and Guidelines for Implementation *(Cir 311).*

airservices

ICAO has published ADS-B Procedures

Separation Standard Guidance in Circular 326

connecting australian aviation

Questions