

Us of 1090 MHz Extended Squitter for ADS-B

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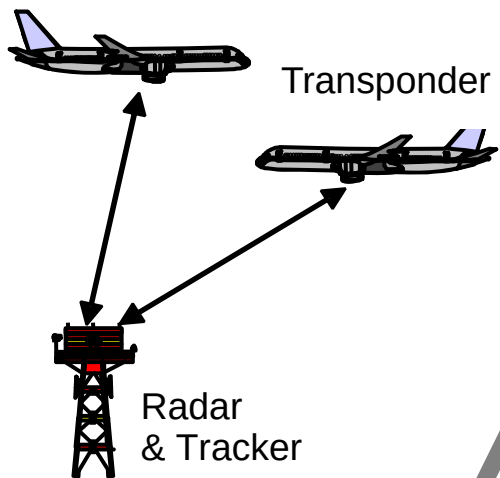
June 2007

ADS-B: A means by which aircraft, aerodrome vehicles and other objects can automatically transmit and/or receive data such as identification, position and additional data, as appropriate, in a broadcast mode.

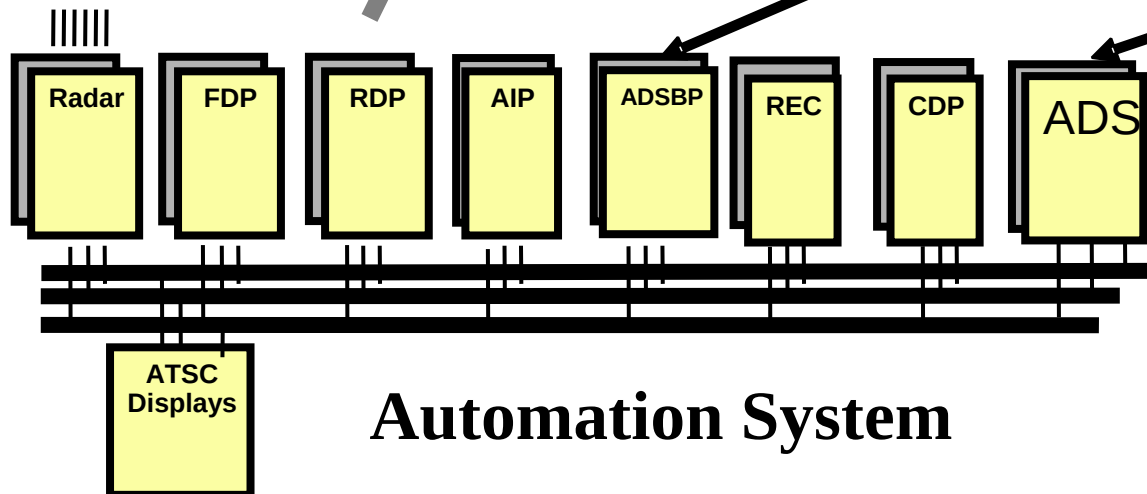
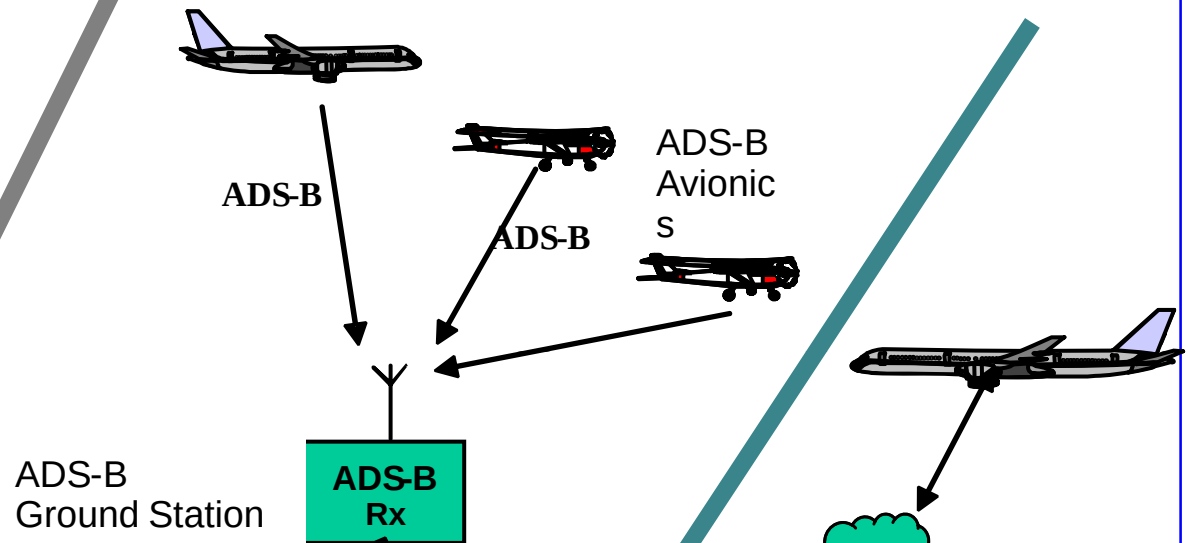
The digital radio that support ADS-B and standardized by ICAO are:

- * 1090 MHz extended squitter (ES)
- * VDL Mode 4
- * UAT

Radar Surveillance

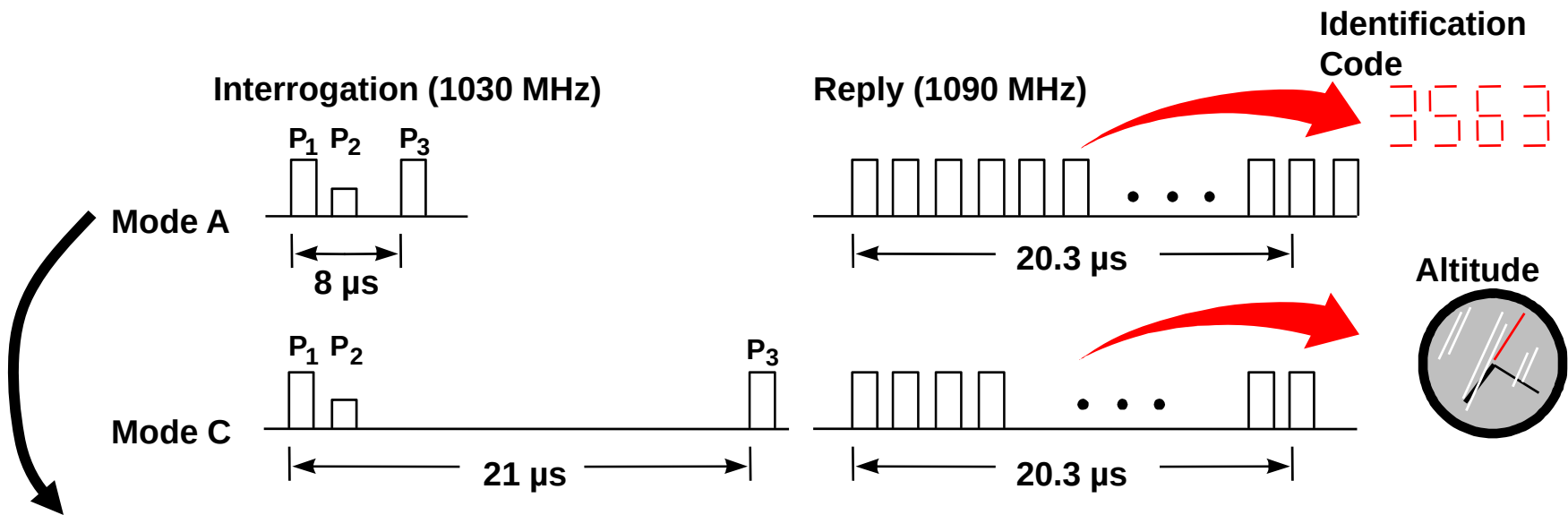
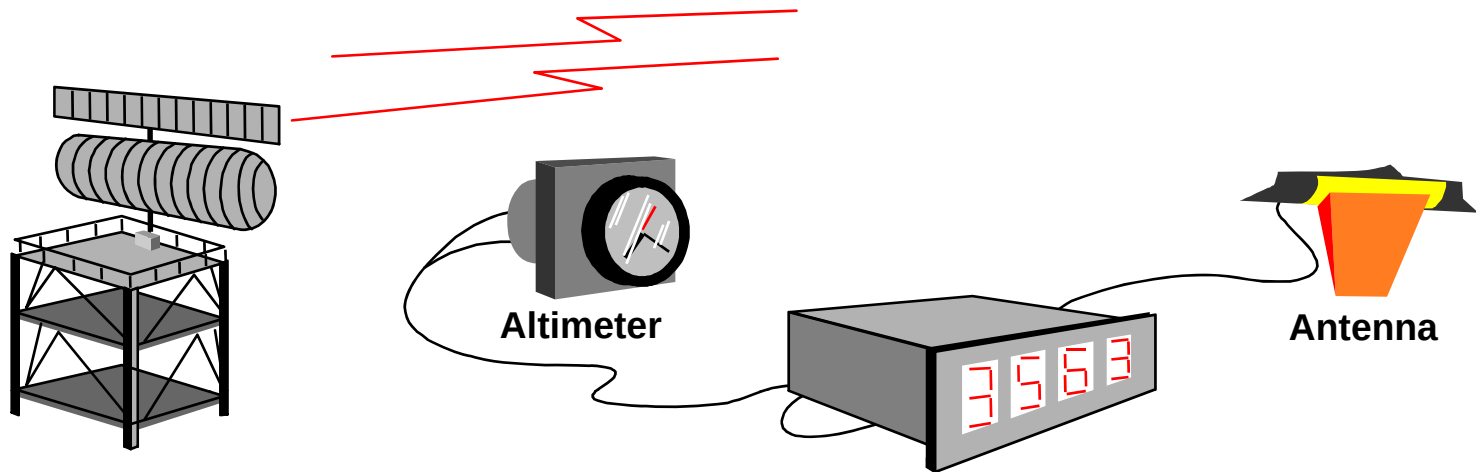


ADS-B Surveillance



Automation System

Identify and altitude in SSR environment



Current ATM systems use Mode A codes associated with call-sign

ADS-B Messages



Not Mode A
codes; an 8
character A/C
ID

Airborne or surface position report

Aircraft identification-Category

Velocity - Heading

Emergency/Priority

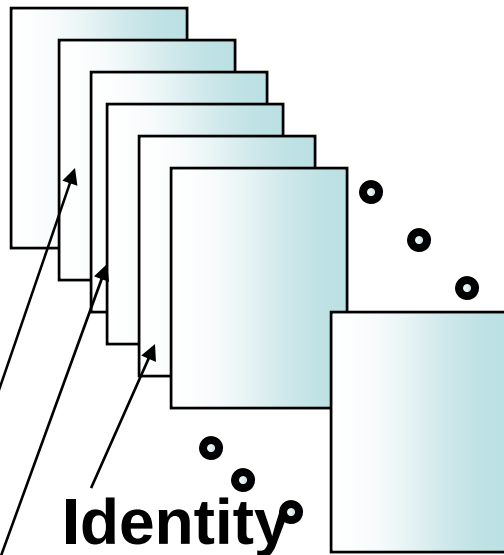
An event-driven information

ACAS RA Broadcast

Operational status

Contents of some registers in Mode S XPDR can be broadcasted with extended squitter hence ADS-B

Registers (00 to FF_{HEX}) contain A/C information



Track and Turn Report

Heading and Speed Report

Mode S transponder

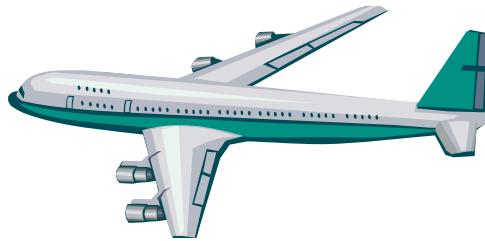


Registers enable downlinking (and broadcasting) of A/C data

1090 MHz Extended Squitter

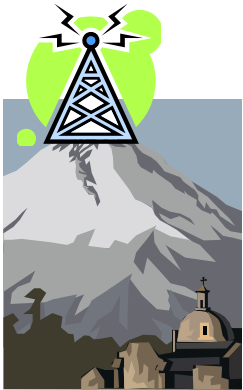
- * Recognized as the most common element in early implementations of ADS-B (11th Air Navigation Conference, Rec.7/1)
- * Standardized by ICAO (Annex 10, Volumes III and IV supplemented by a new manual (Doc 9871))
- * Certified airborne equipment and ground stations (for air-to-ground ADS-B) commercially available

1090 ES transmitters



A/C in flight

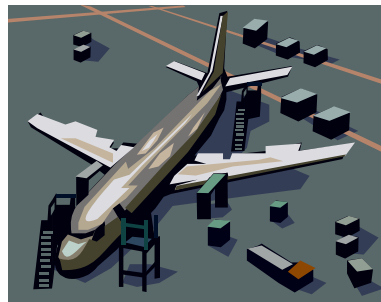
ES rate is slightly randomized and varies from 2/s (for position/velocity) 0.2/s (for identification)



Obstacle



TIS-B
Station



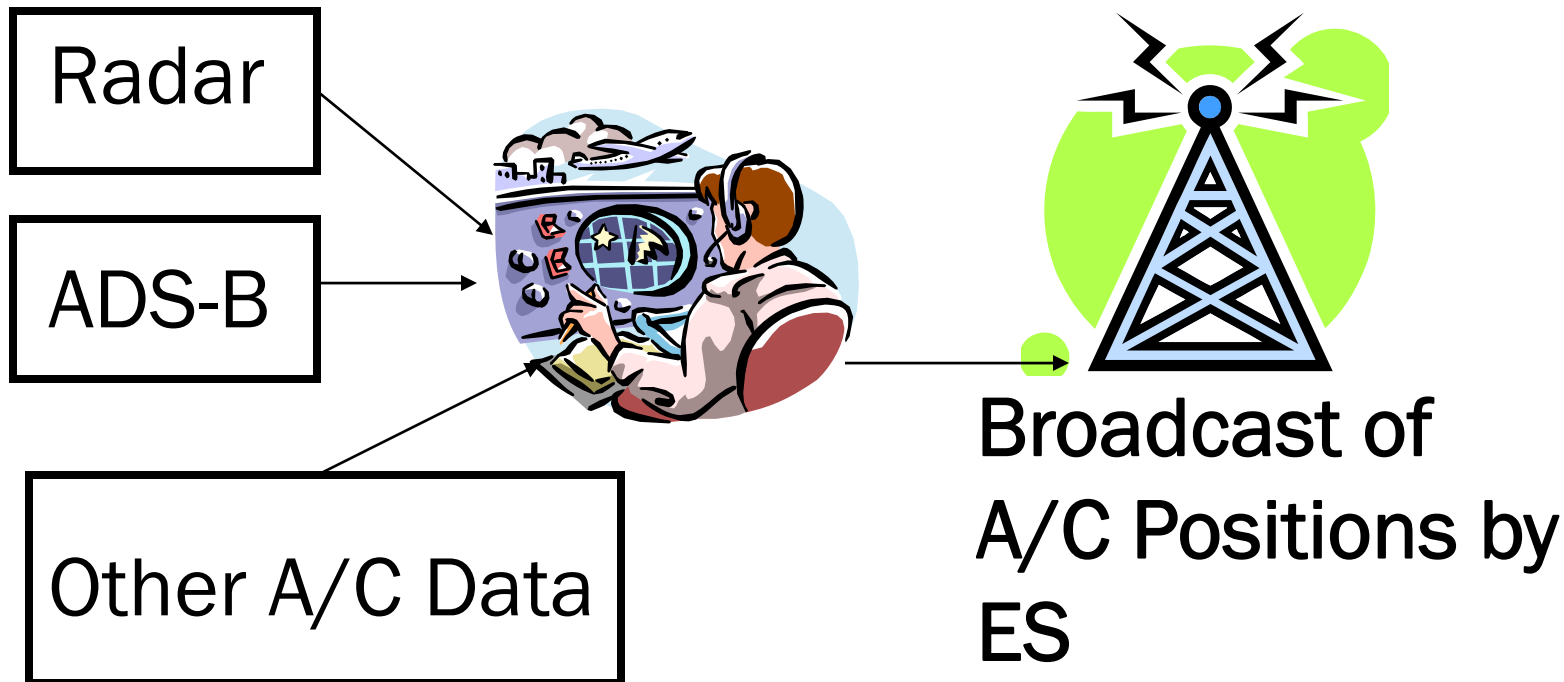
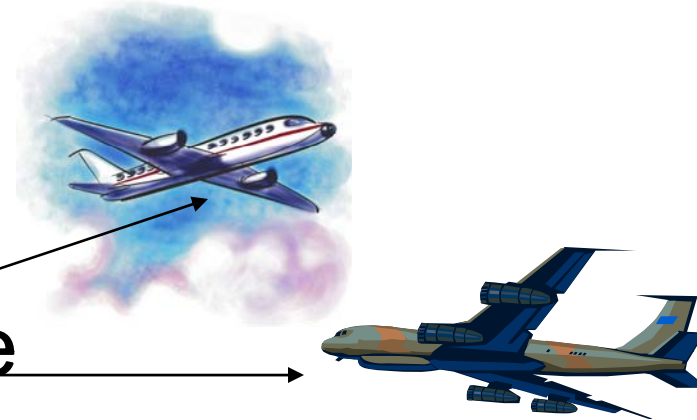
A/C on ground



Surface vehicle

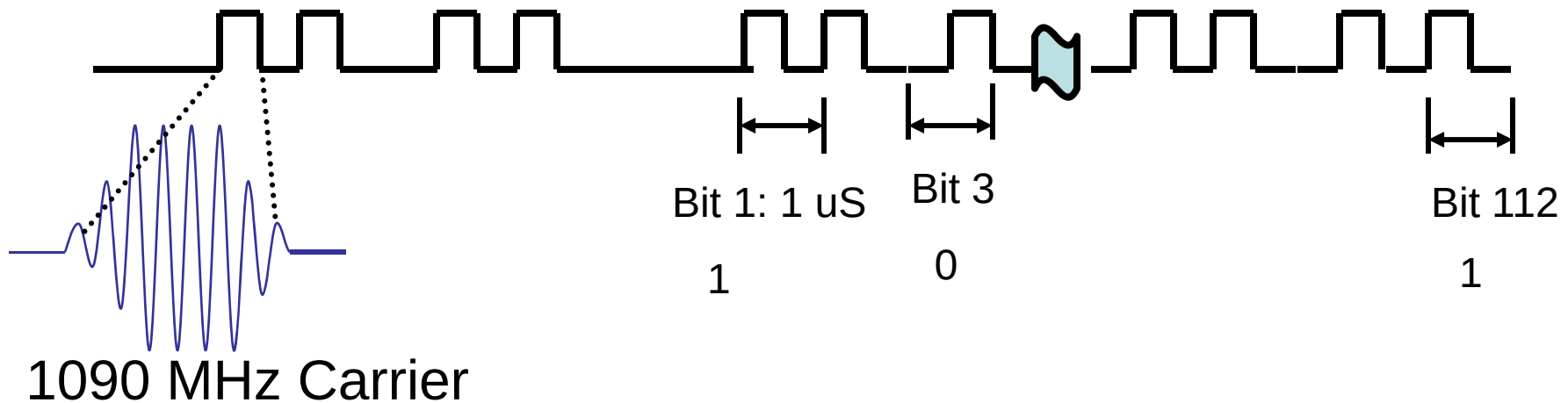
Traffic Information Service - Broadcast (TIS-B) ADS-Rebroadcast (ADS-R)

Aircraft has to be equipped with ES receiver/display to use the service

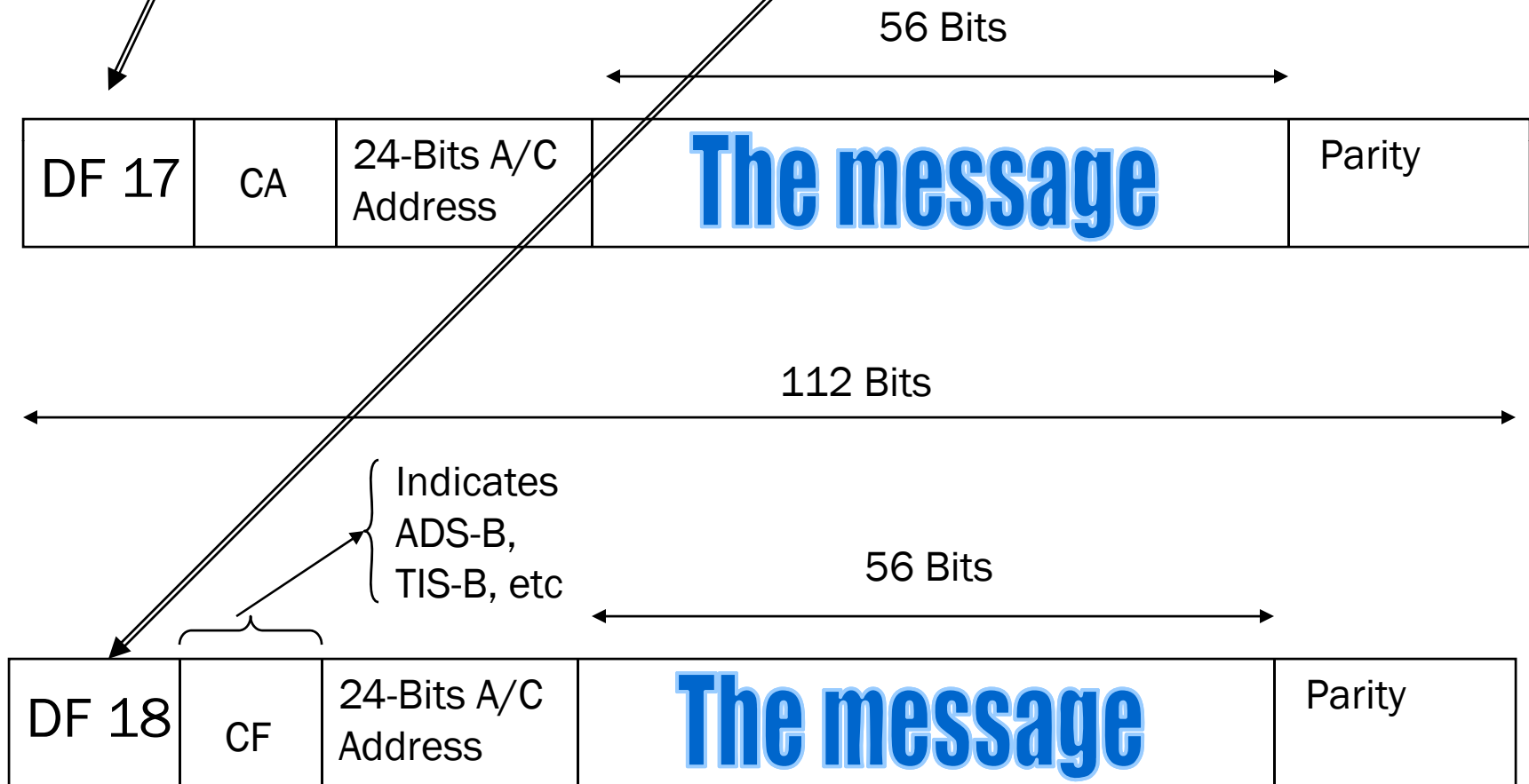


1090 ES Signal In Space

Same as for Mode S reply to ground interrogation



ES signal can be emitted from Mode S transponders or non-transponder (NT) devices (airborne or else)



The 24-bit aircraft address is essential for Mode S and ADS-B

- Annex 10, Volume III, part I shows a worldwide scheme for allocation/assignment of this address
 - Provides blocks of consecutive addresses to ICAO States for assignment to aircraft
 - 24 bits --> 16,777,216 addresses allocated among 177 States

	Country Code	No. of Aircraft Addresses
<u>Afghanistan</u>		
0111 0000 0000 - - - - -	700 ₁₆	12 bits = 4096
⋮		
<u>United States</u>		
1010 - - - - -	A ₁₆	20 bits = 1,048,576
⋮		
<u>Zimbabwe</u>		
0000 0000 0100 00 - - - - -	004x ₁₆	10 bits = 1024

ES Versions

Version 0: In Annex 10 since 2002

Version 1: Being processed

Version number only affects the message contents

The two versions are interoperable (as per SARPs)

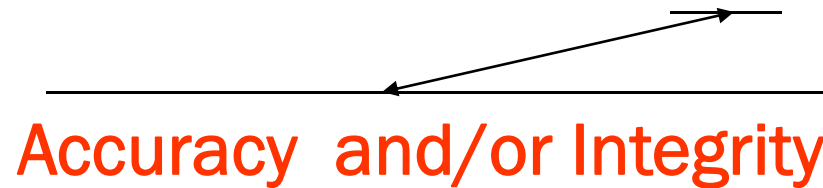
Version 1 has more elaborate indication of accuracy and integrity.

Both versions described in Doc 9871.

More on Integrity, Accuracy, etc

The aircraft should indicate in its ADS-B messages how much trust can be placed on its reported **position** and **velocity**.

Version 0: Navigation Uncertainty (NUC)



NUC_P (for position): From 0 to 9

NUC_R: (for velocity): From 0 to 4

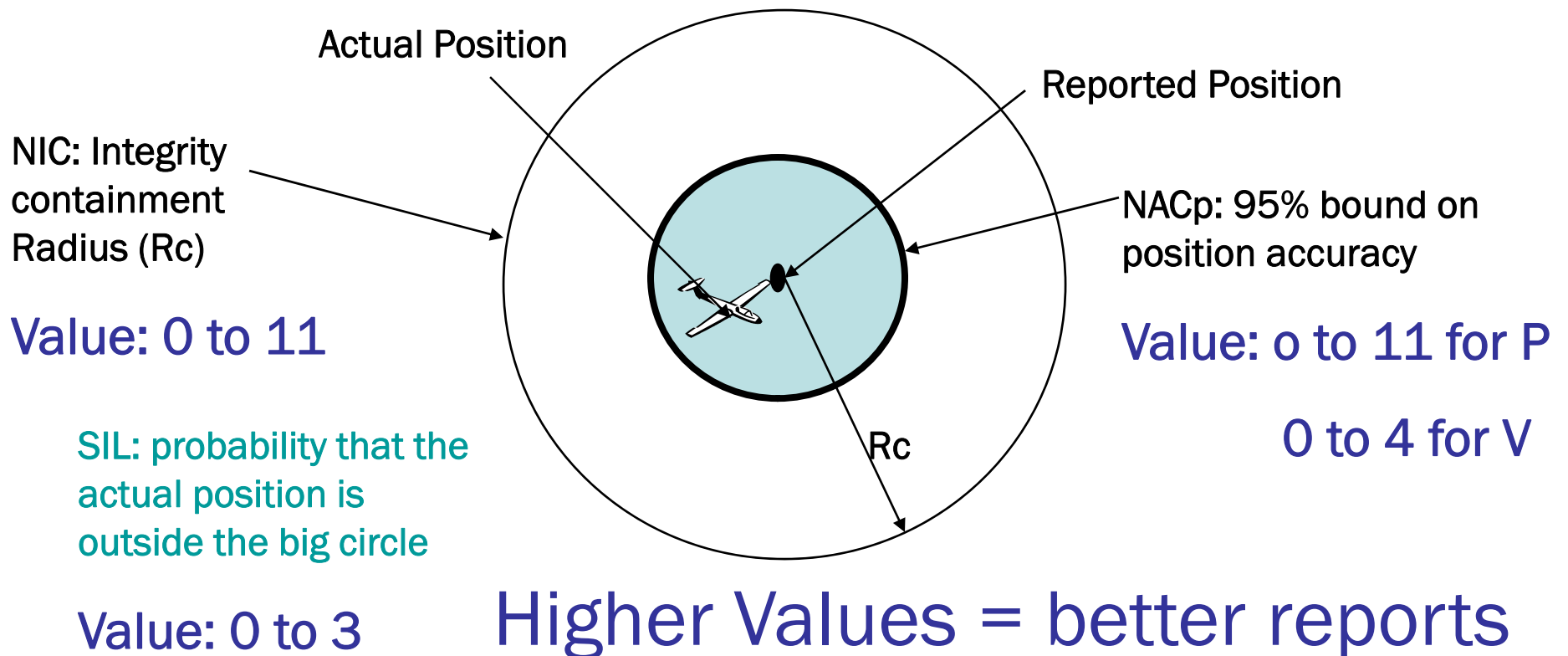
Higher NUC = Higher report quality

More on Integrity, Accuracy, etc

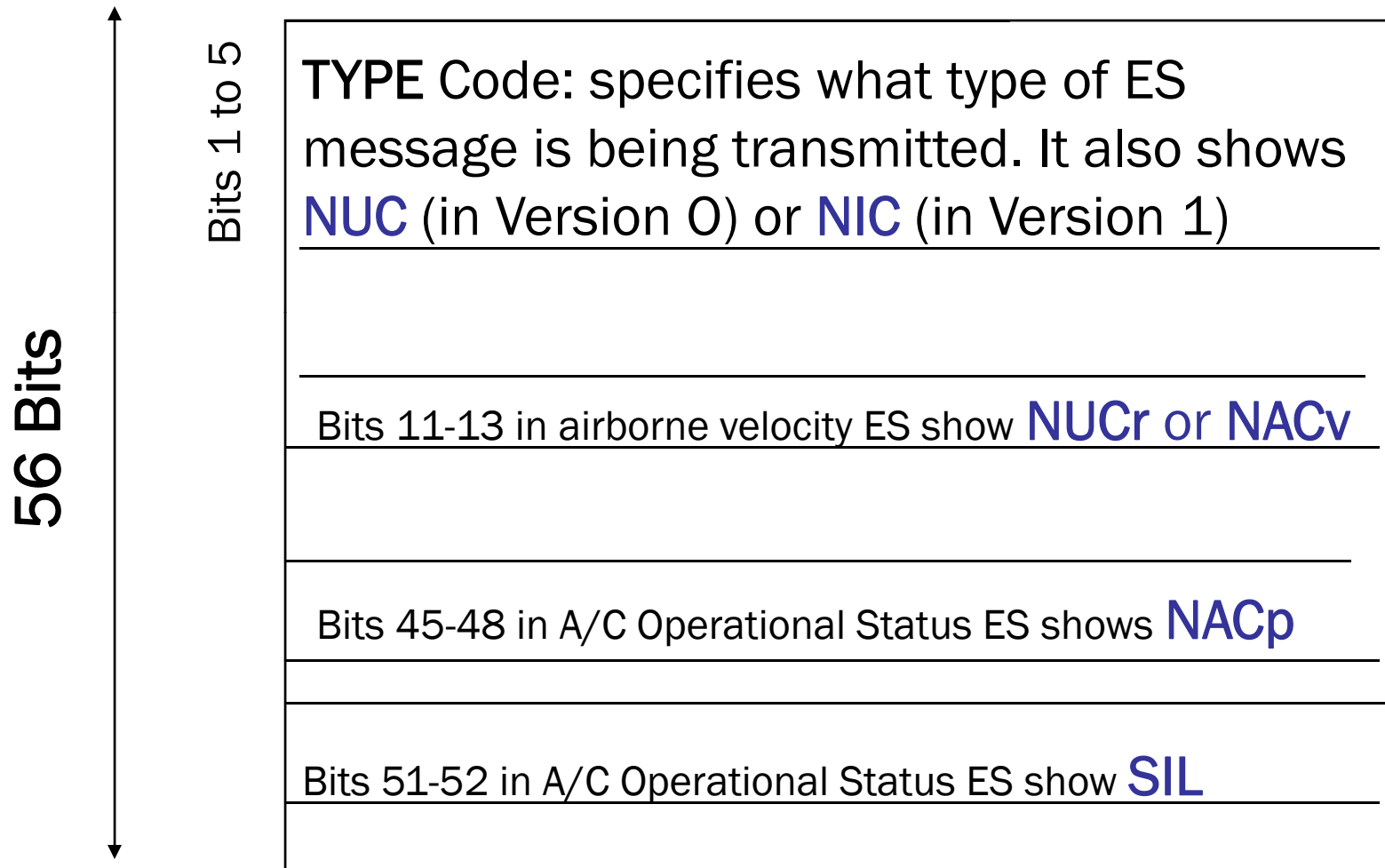
Version 1: Navigation Accuracy Category (NAC)

Navigation Integrity Category (NIC)

Surveillance Integrity Level (SIL)



More on Integrity, Accuracy, etc



Is ADS-B as good as SSR?

Early studies suggest that minimum requirements for ADS-B to enable 5 NM separation (like for SSR) should be:

$NAC \geq 7$ (i.e. accuracy of 0.1 NM or better)

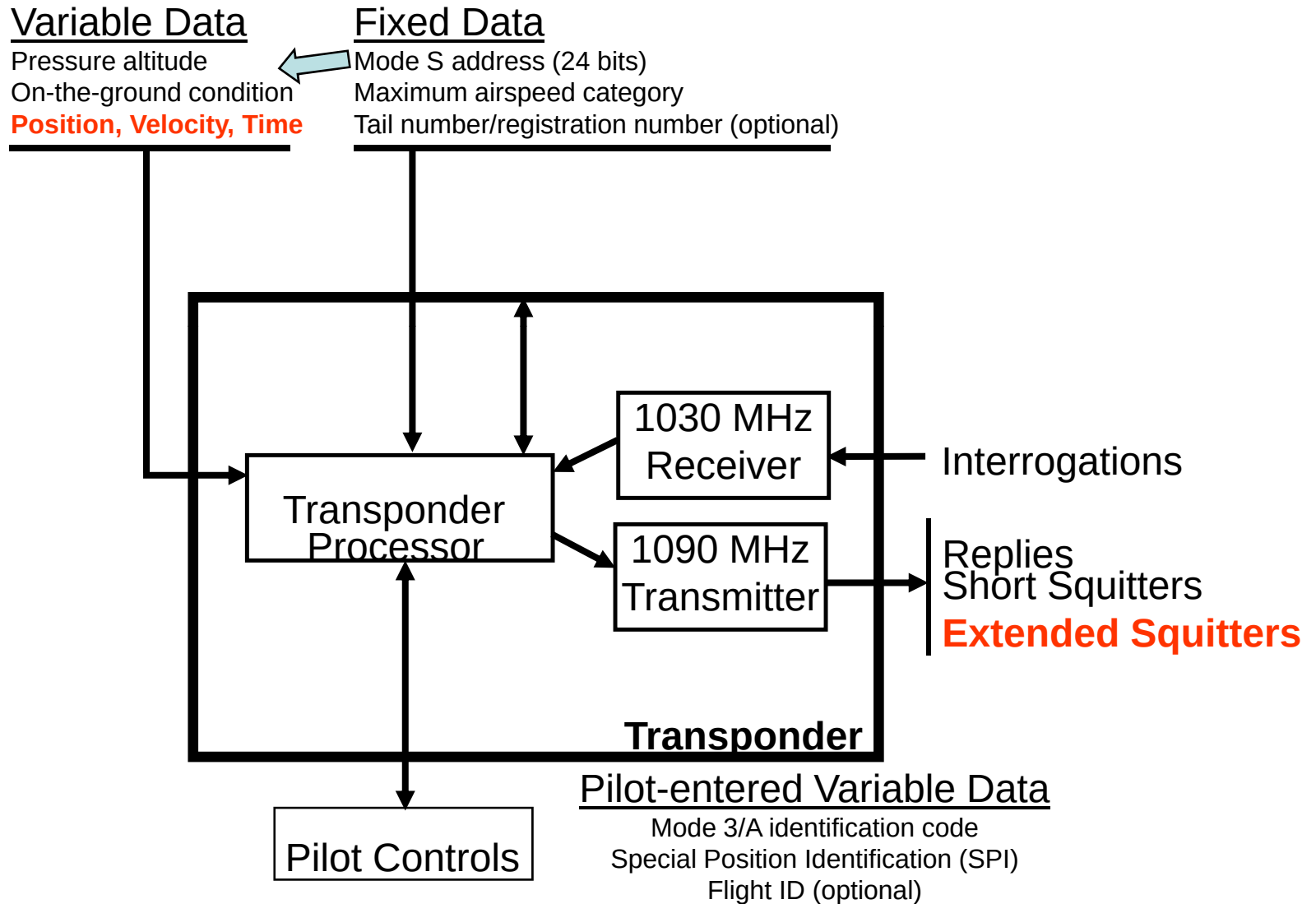
$NIC \text{ (or } NUC) \geq 5$ (i.e. $R_c = 0.5$ NM)

$SIL \geq 2$ (i.e. Prob. Of exceeding $R_c \leq 10^{-5}$)

Latency ≤ 4 Seconds

Update rate $\geq$ once every 12 Seconds:

Airborne equipment for ADS-B Out (using a Mode S transponder)



A Navigation source (most commonly a GNSS receiver) is needed onboard to enable ADS-B
ADS-B (for position and velocity information)

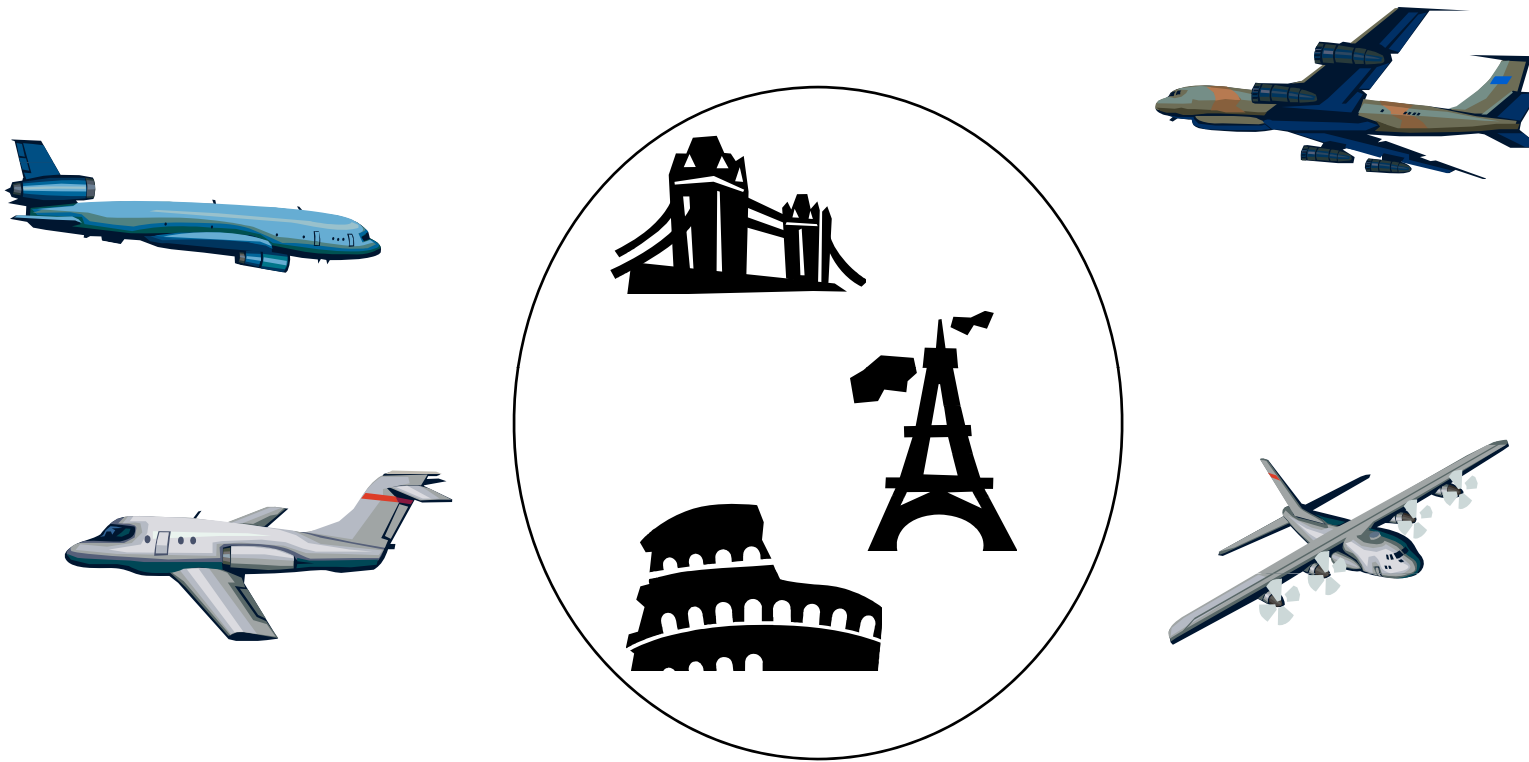
Alternate navigation sources are available on many large aircraft

- INS (Inertial Navigation System)

- DME / DME ranging (Distance Measuring Equipment)

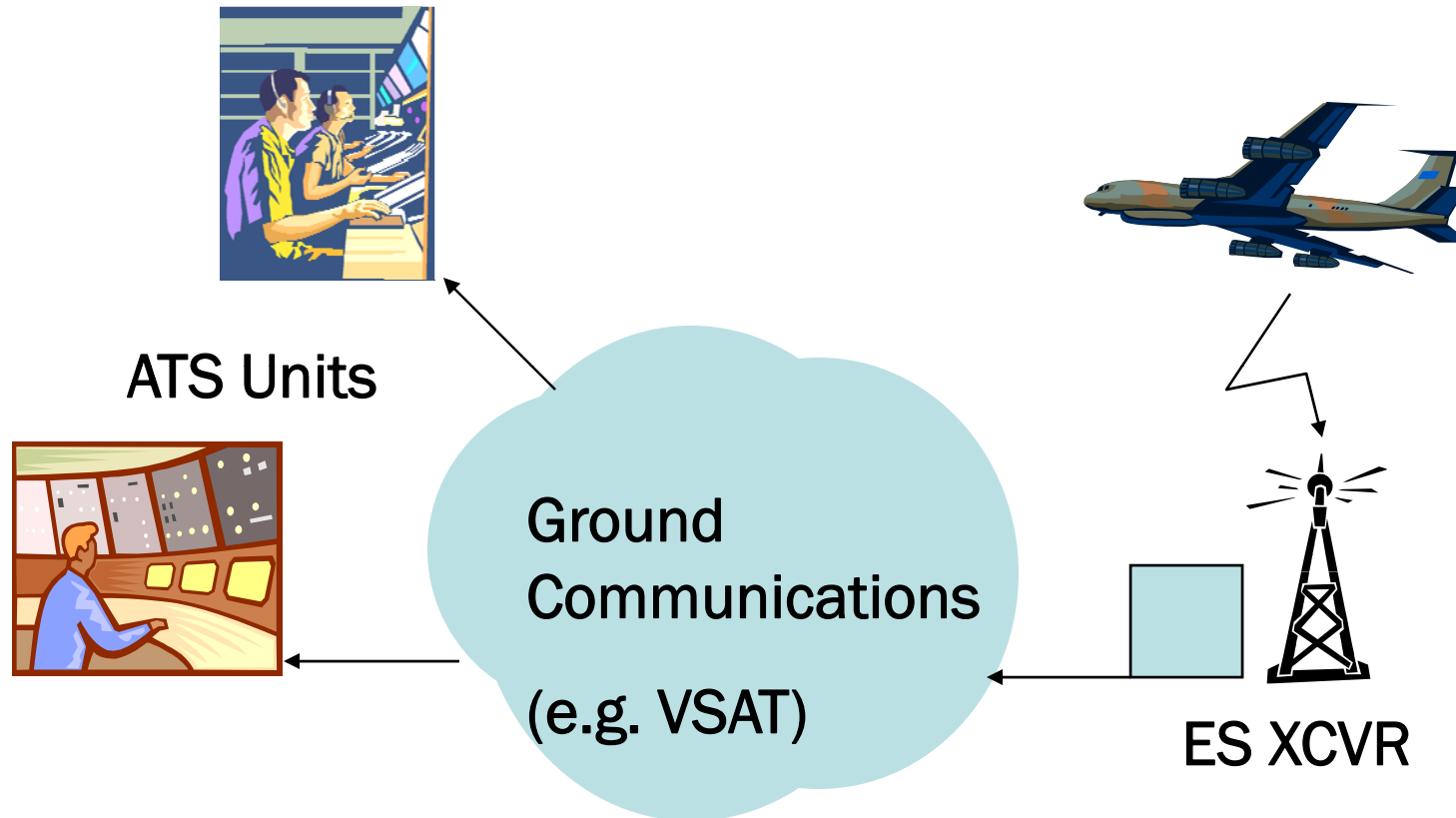
For small aircraft (General Aviation), GNSS is the best navigation data source

Aircraft equipage



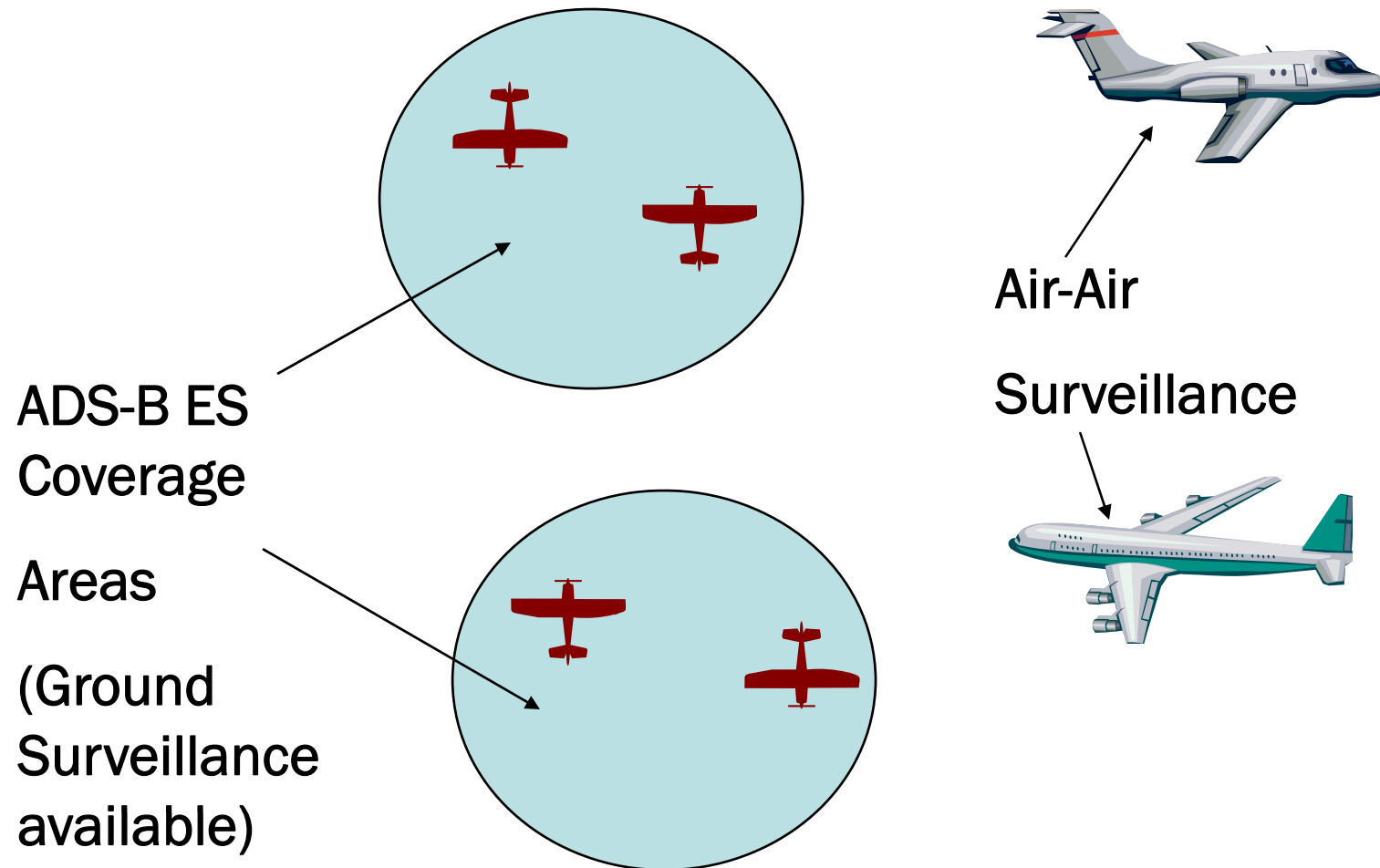
As part of Elementary and Enhanced Surveillance mandates, most aircraft flying in/to Europe are already ES-capable. Other Mode S transponders can easily be upgraded

What about the ground infrastructure?



A proper ground infrastructure is required to ensure timely delivery of ADS-B messages to ATS units. The system should provide proper availability, integrity, transit time and so on in order for the data to be operationally useful.

Equipage of A/C with “ADS-B Out and In” improves situational awareness in the flight deck.



Related Documents

Annex 10, volume IV (Broad SARPs on ES)

Doc 9871 – Technical Provisions for Mode S Services and Extended Squitter

(In production – draft version available on the SCRSP website

www.icao.int/anb/panels/scrsp)

RTCA DO 242A – MASPS for ADS-B

RTCA DO 260 – MOPS (ES Version 0)

RTCA DO 260 A – MOPS (ES Version 1)

Thank you
Any Questions?

