

EVOLUTION OF AERONAUTICAL SURVEILLANCE

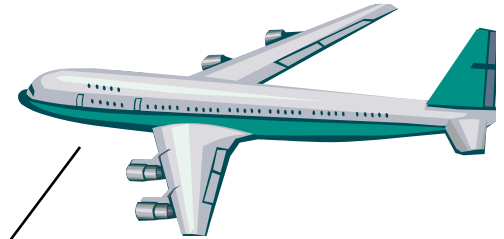
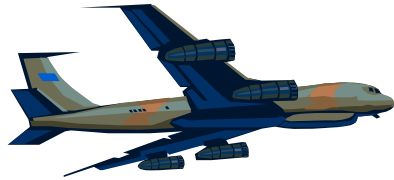
By: M. Paydar

**Technical Officer (CNS)
Air Navigation Bureau
International Civil Aviation Organization**

June 2007

Aeronautical Surveillance

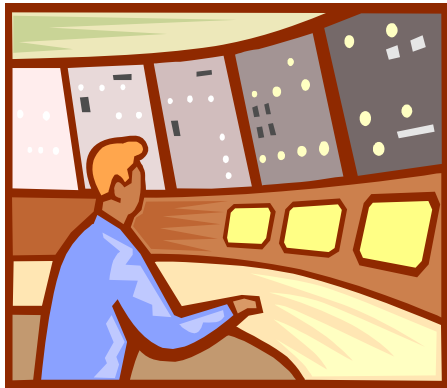
Airborne Surveillance



Identification

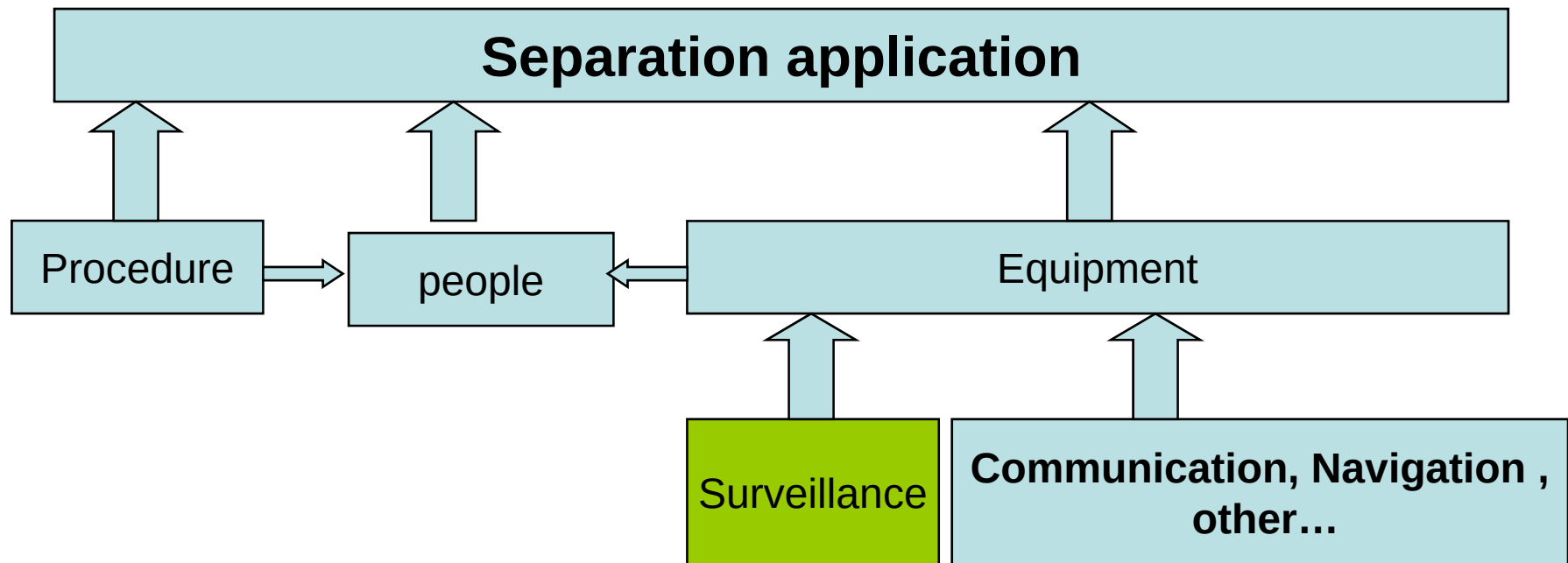
Position (at what time?)

Additional info (e.g. velocity)

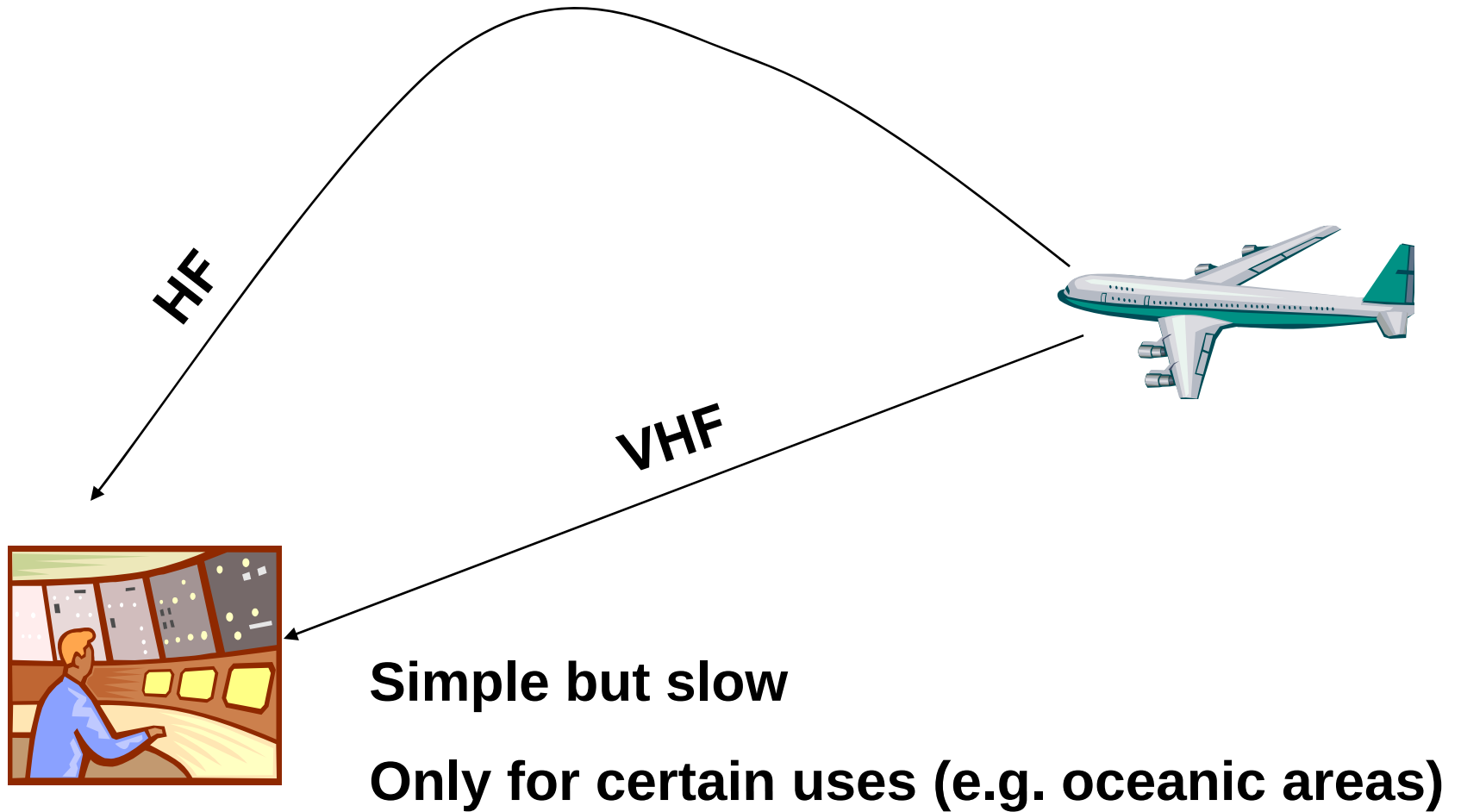


Ground Surveillance

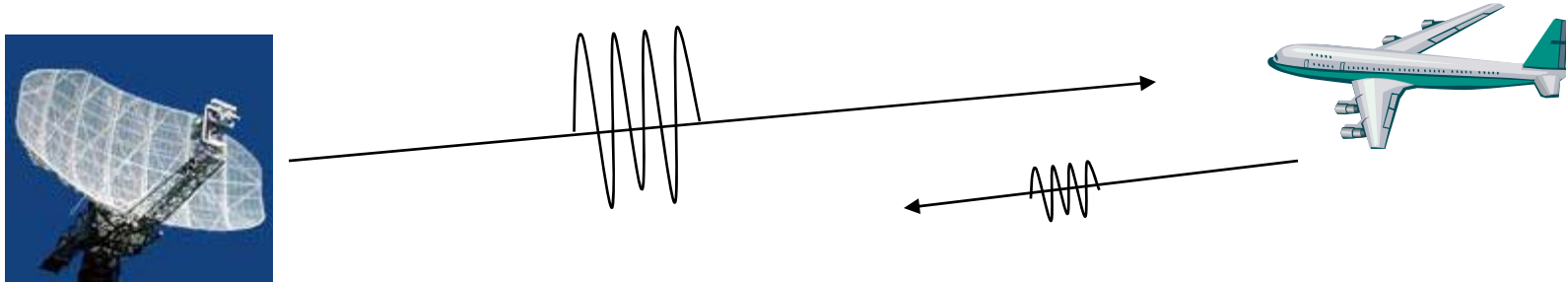
Use of Surveillance



Voice Position Reporting

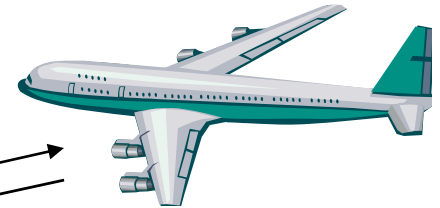


Primary surveillance radar (PSR)



- * Detects all flying objects - A/C equipage not an issue
- * Doesn't provide A/C identity, altitude or other information
- * Rather expensive to install and maintain – high power needed for long range is an environmental hazard
- * Low update rate (once every 4 to 12 S)
- * Vulnerable to interference, noise and clutter

secondary surveillance radar (SSR)



Interrogation

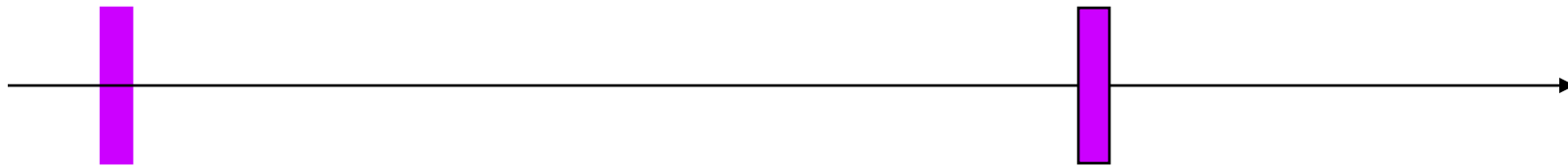
Reply



- * Requires A/C transponder
- * Needs less power (than PSR)
- * Provides information on A/C identity and pressure altitude (through Modes A and C)
- * Not affected by noise and clutter
- * Can suffer from garbling/FRUIT

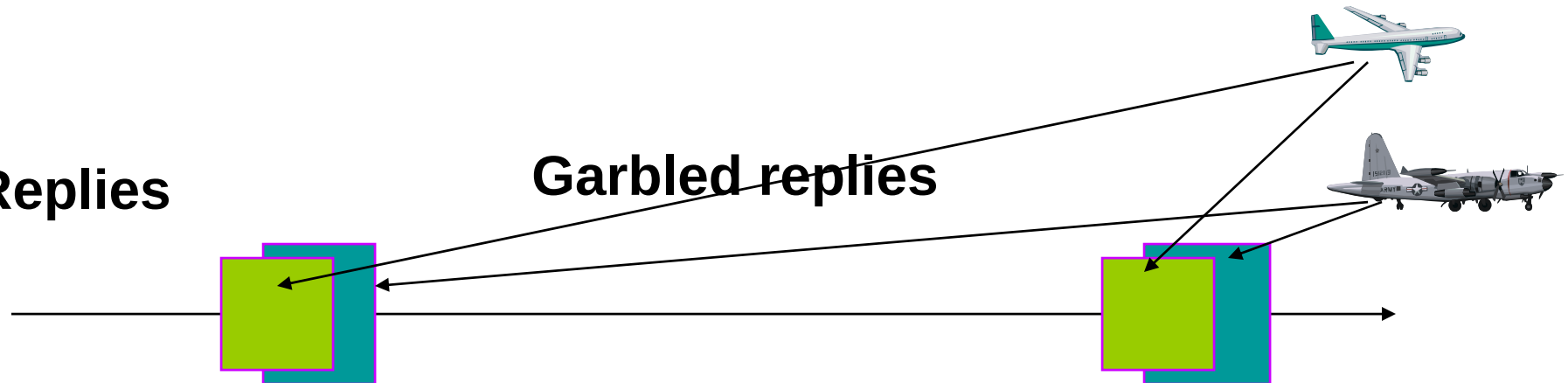
More on SSR (Modes A and C)

Interrogations



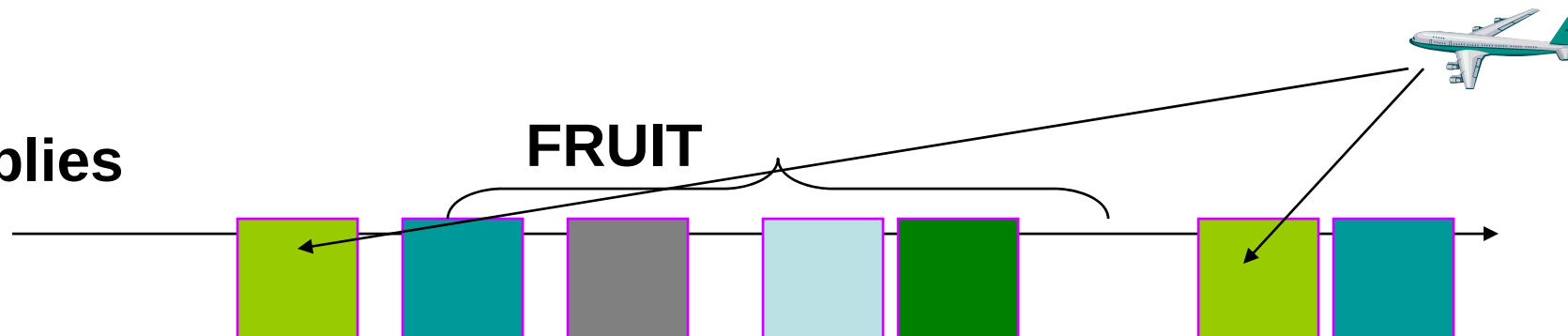
Replies

Garbled replies



Replies

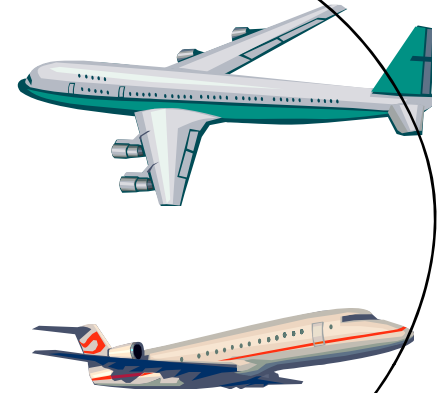
FRUIT



SSR Mode S

Mode S: The answer to garbling and FRUIT (mainly in high density areas)

Aircraft can be selectively interrogated

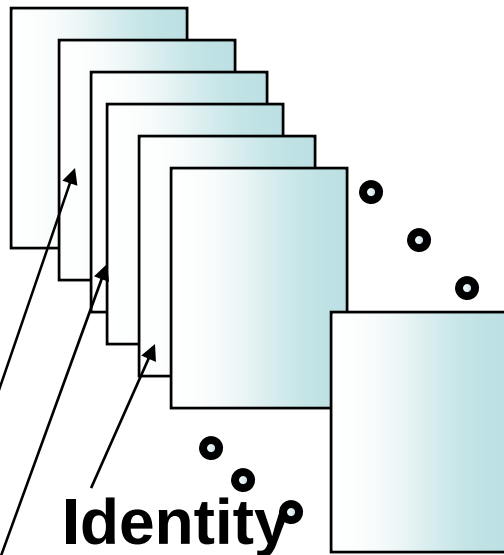


- * Can resolve closely spaced targets**
- * A/C identity and altitude protected against errors**
- * Can provide altitude in 25 ft increments**
- * Can provide much more A/C information**
- * Needs Mode S transponder (needed for ACAS)**
- * More complex to set up and operate**

SSR Mode S Transponder

Can house some registers

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



Track and Turn Report

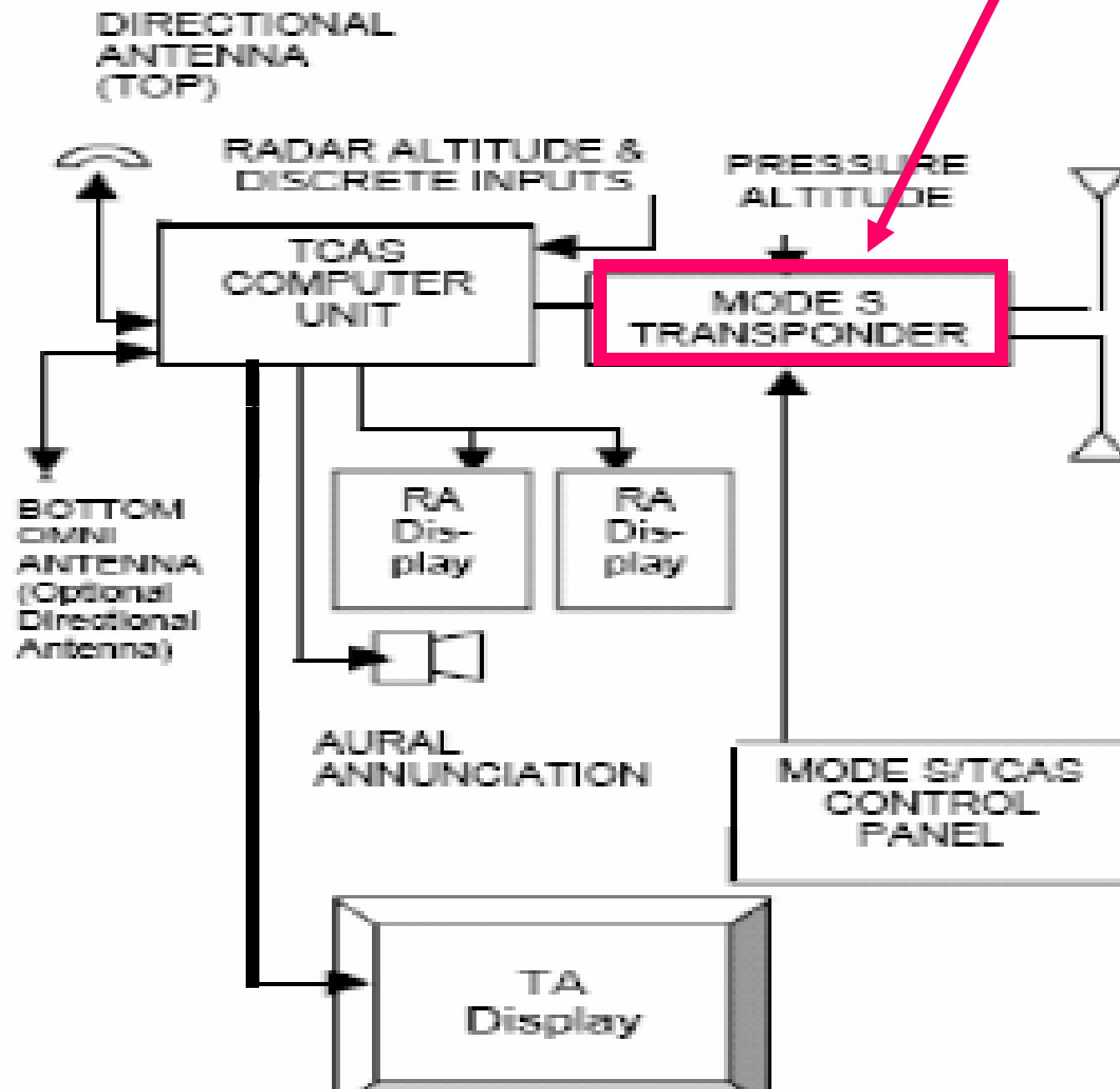
Heading and Speed Report

Mode S transponder



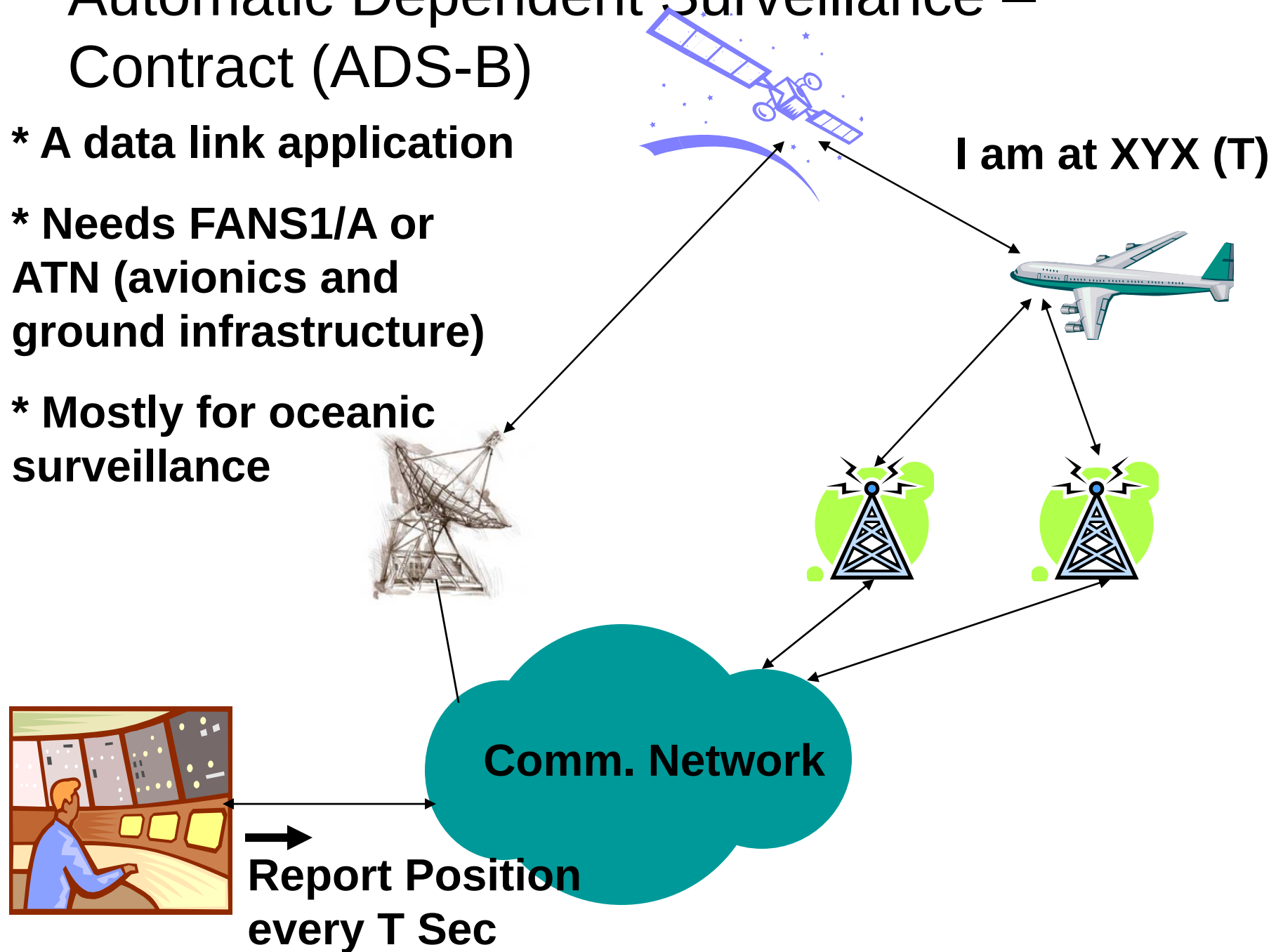
Registers enable
downlinking (and
broadcasting) of A/C data

Mode S Transponder is an integral part of ACAS



Automatic Dependent Surveillance – Contract (ADS-B)

- * A data link application
- * Needs FANS1/A or ATN (avionics and ground infrastructure)
- * Mostly for oceanic surveillance

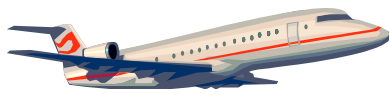


Automatic Dependent Surveillance – Broadcast (ADS-B)

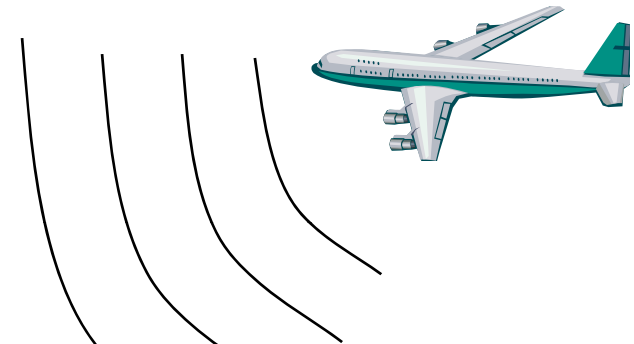
(1090 ES, VDL M4 or UAT) I am at **XYX (T)**

ADS-B OUT

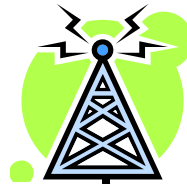
ADS-B IN



**Airborne
Surveillance**



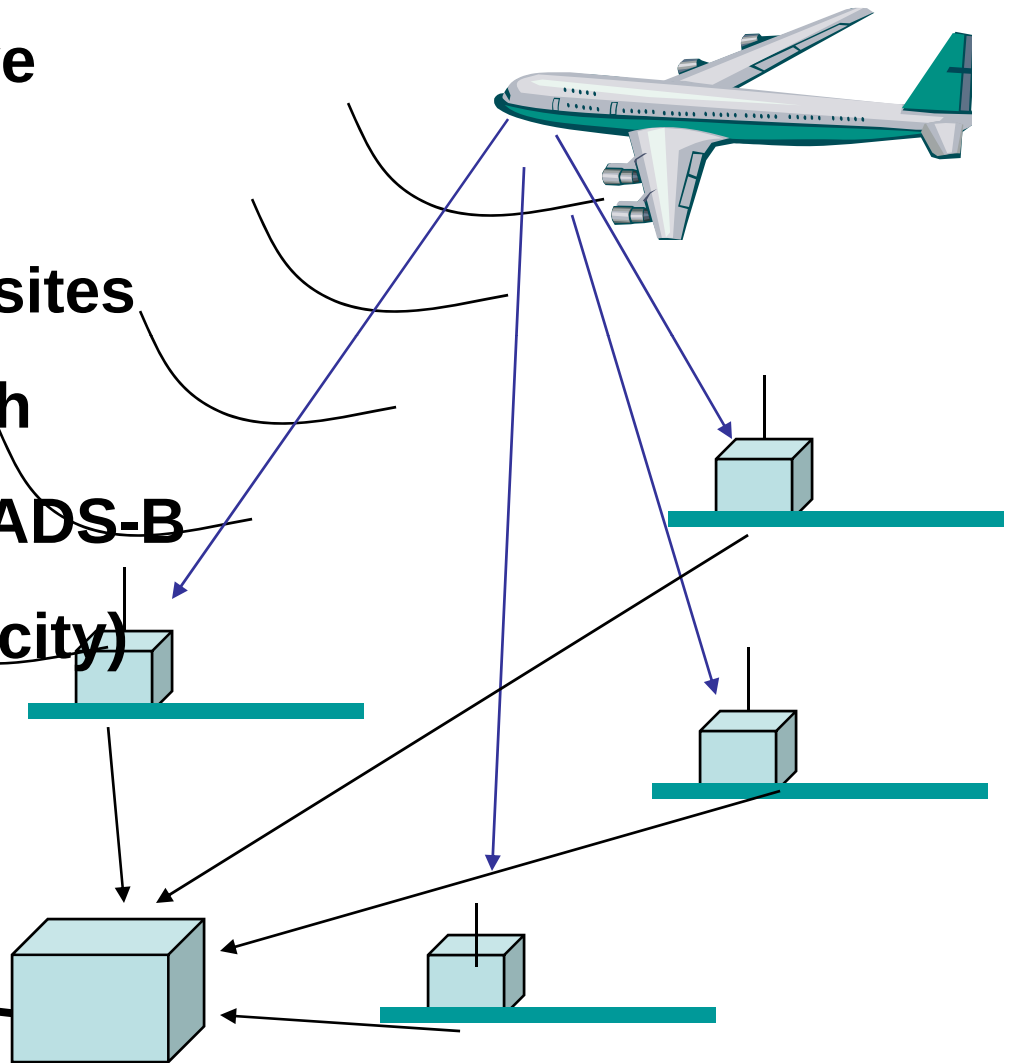
**Ground
Surveillance**



- * High update rate
- * Cheaper than radar
- * A/C equipage required
- * Immune to multipath
- * May need independent verification of the authenticity of the reports

Multilateration system

- * Uses SSR replies from the A/C
- * Can be passive or active
- * High update rate
- * Needs a number of RX sites
- * Susceptible to multipath
- * Can be combined with ADS-B
(can then check authenticity)



Status of Standardization

PSR: Not standardized

SSR: Mature, SARPs in Annex 10

ADS-C: Forms part of ATN SARPs and related data
link applications (FANS-1/A not done by ICAO)

ADS-B: VDL Mode 4 : SARPs in Annex 10

UAT: SARPs part of Amendment 82 (Nov. 07)

1090 ES: Version 0 (Amendment 77 in 02)

Version 1 (Amendment 82 (Nov 07)

Note: *Data formats for both versions to
be included in Doc 9871*

Multilateration: Being standardized (1st draft in late 08)

Relevant ICAO Technical Documents

***Annex 10 – SARPs**

***Manual on the SSR Systems (Doc 9684)**

***Manual on Testing of Radio Navaids (Doc 8071), Vol III
(Testing of Surveillance Radar Systems)**

***Manual on Mode S Specific Services (Doc 9688)**

***ACAS Manual (Doc 9863)**

***Technical Provisions for Mode S Services and
Extended Squitter (Doc 9871 – under publications)**

*** Manual on UAT (Doc 9861 – under publication)**

*** Manual on VHF Digital Link (VDL) Mode 4. (Doc 9816)**

*** Circular 311 Assessment of ADS-B to Support ATS and
Guidelines for Implementation. Draft, 1st Edition.**

Traditional ICAO approach: Define the signal in space for various technical systems to ensure interoperability and leave to States to decide which system (s) should be implemented in their airspace.

PSR

ADS-B

**SSR (Mode
A/C and/or S)**

MLAT



What is the decision based on?

**Sensor
characteristics**

Operational requirements

Regional agreements

Cost considerations

Aircraft equipage

Other factors



An ideal situation?

Operational scenario

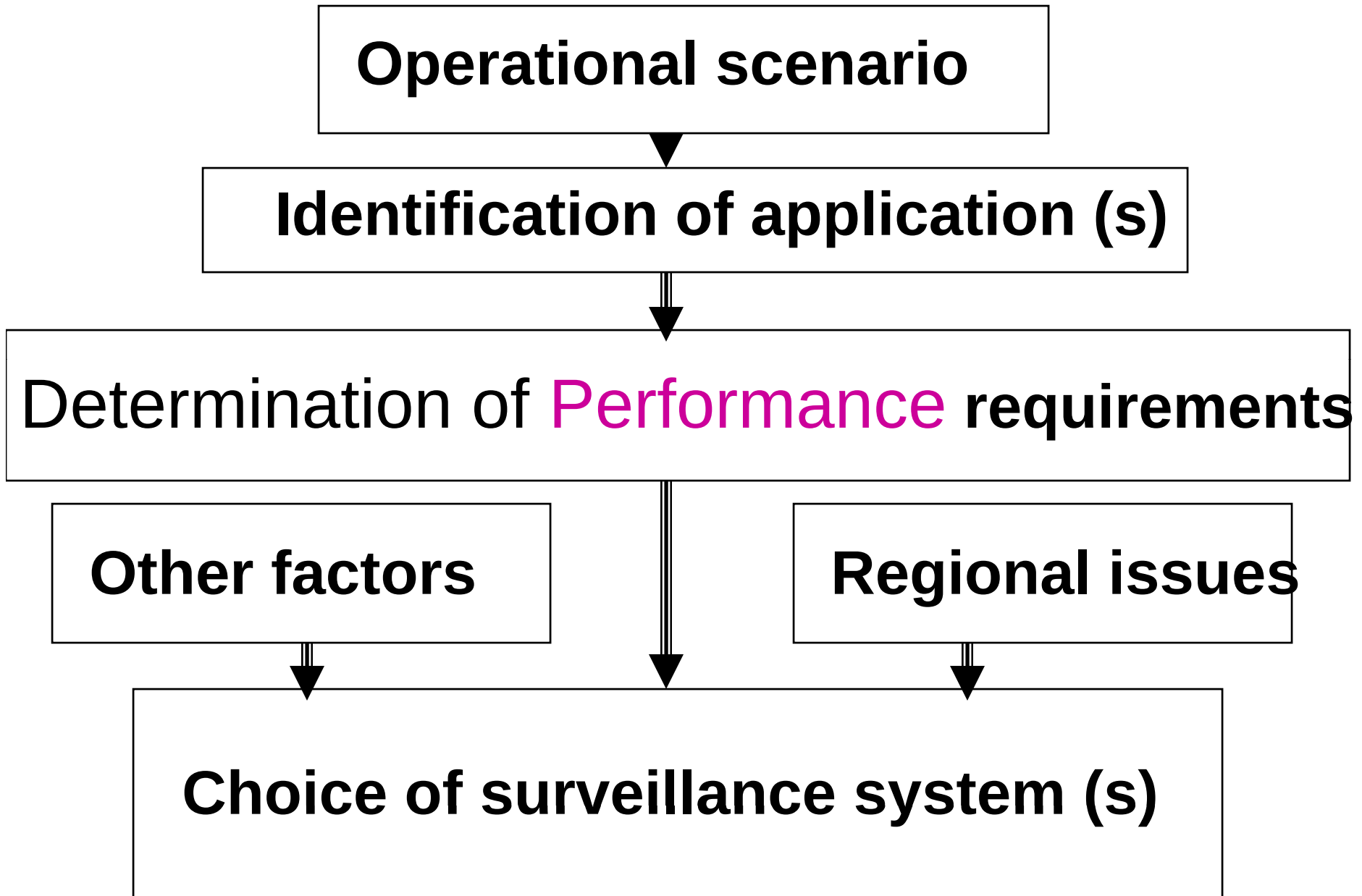
Identification of application (s)

Determination of Performance requirements

Other factors

Regional issues

Choice of surveillance system (s)



A framework has been developed for the required surveillance performance (RSP) which has a set of values (e.g. from A1 to A10) each of which is associated with set figures for:

Accuracy

Availability

Integrity

Latency

Update rate

Continuity

Coverage

Aeronautical Surveillance Panel

The ICAO body of experts responsible for the upkeep and the development of surveillance-related provisions such as:

- * SSR (all modes)**
- * 1090 MHz extended squitter (for ADS-B)**
- * ACAS**
- * Multilateration**
- * Required Surveillance Performance (RSP)**
- * Airborne surveillance applications**

Thank You for Your Attention