

# **AIR TRAFFIC CONTROL TRANSPONDER**

**A transponder (XPDR) is a receiver/transmitter which will generate a reply signal upon proper interrogation; the interrogation and reply being on different frequencies.**

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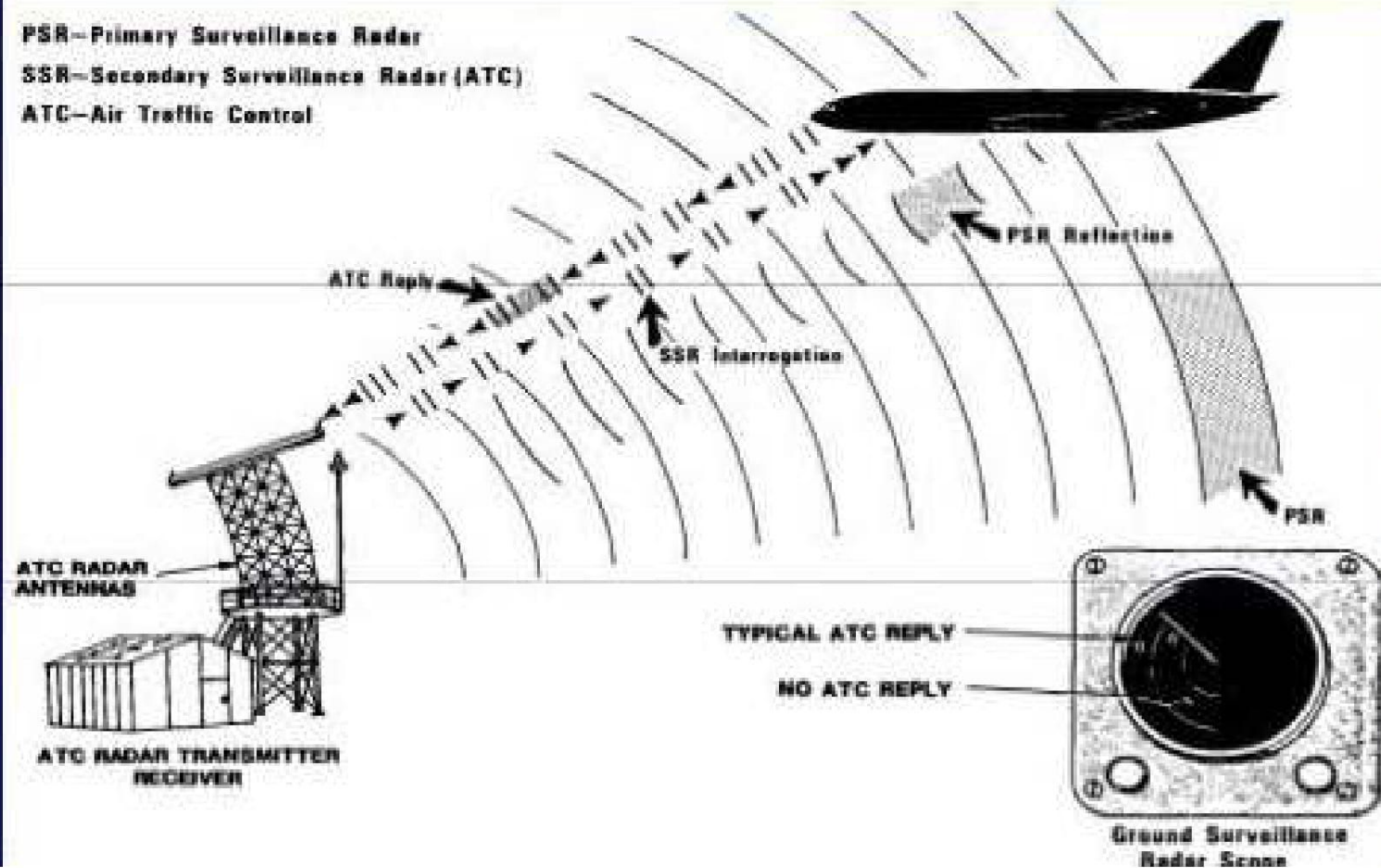
# ➤ AIR TRAFFIC CONTROL TRANSPONDER

## Principles of ATC Transponder

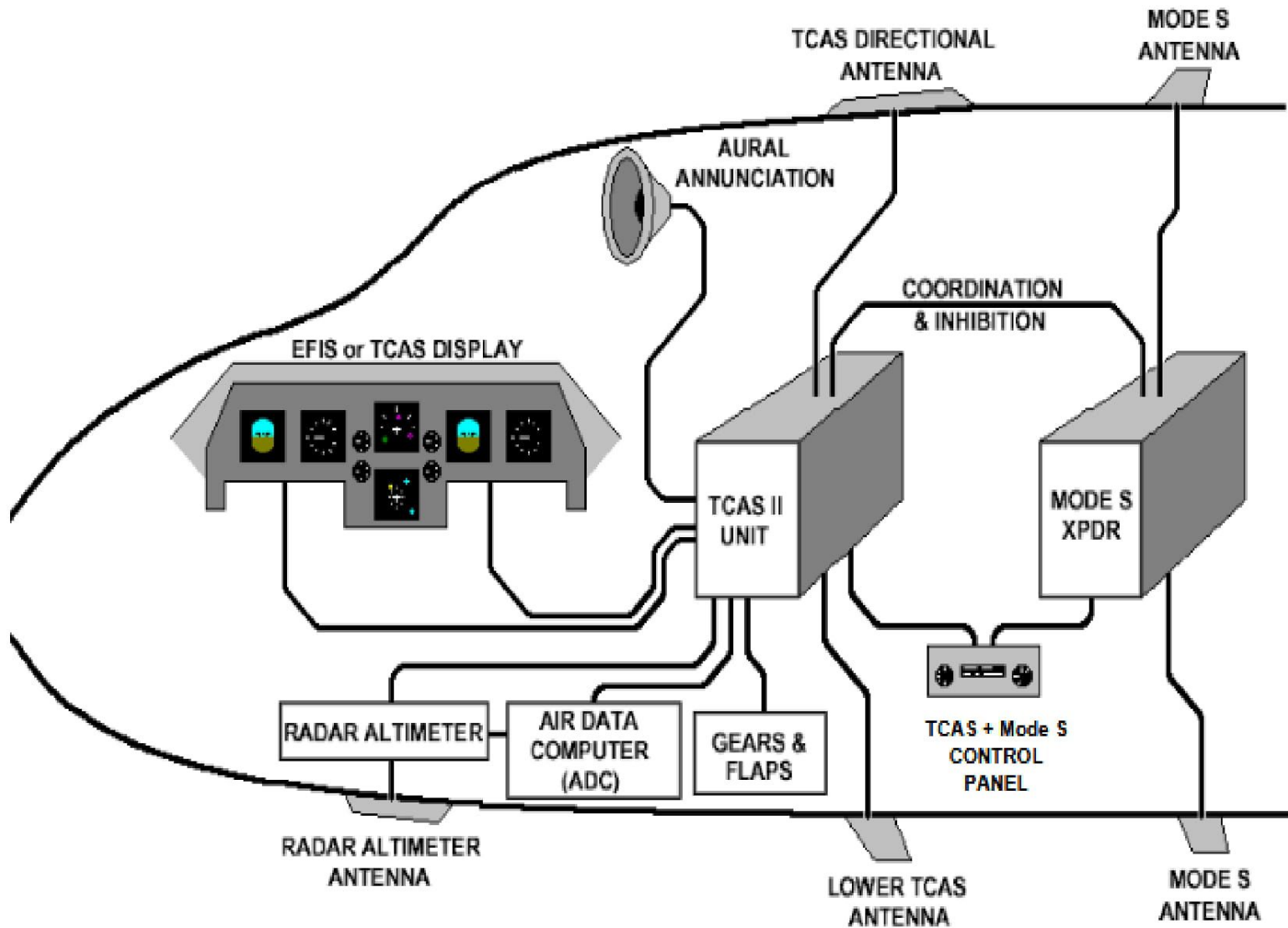
PSR—Primary Surveillance Radar

SSR—Secondary Surveillance Radar (ATC)

ATC—Air Traffic Control



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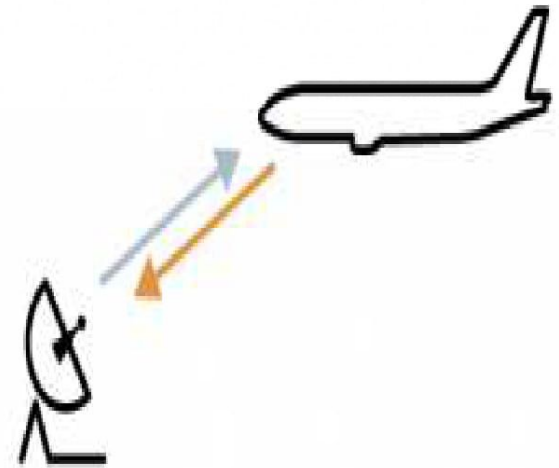


## ➤ **AIR TRAFFIC CONTROL TRANSPONDER**

- ✓ Transponders first came into use to enable military authorities to identify friendly aircraft, which transmitted a coded signal when interrogated by military radar.
- ✓ This was known as IFF (Identification Friend or Foe).
- ✓ Subsequently, transponders have come into widespread use in civil as well as military aviation.
- ✓ It is now standard practice to allocate a specific transponder code to each aircraft flying in controlled airspace so that the ATCO can readily identify a specific aircraft on a crowded radar screen, using SSR (Secondary Surveillance Radar).

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- ✓ By international agreement, 2000 is used for aircraft which have not been assigned a transponder code, although in some parts of Europe, 7000 is used for this purpose.
- ✓ Details of standard codes in different countries may be found in national Aeronautical Information Publications (AIPs).
- ✓ Special codes are used in emergency, a
  - hi-jack (7500)
  - loss of commu
  - general emerg

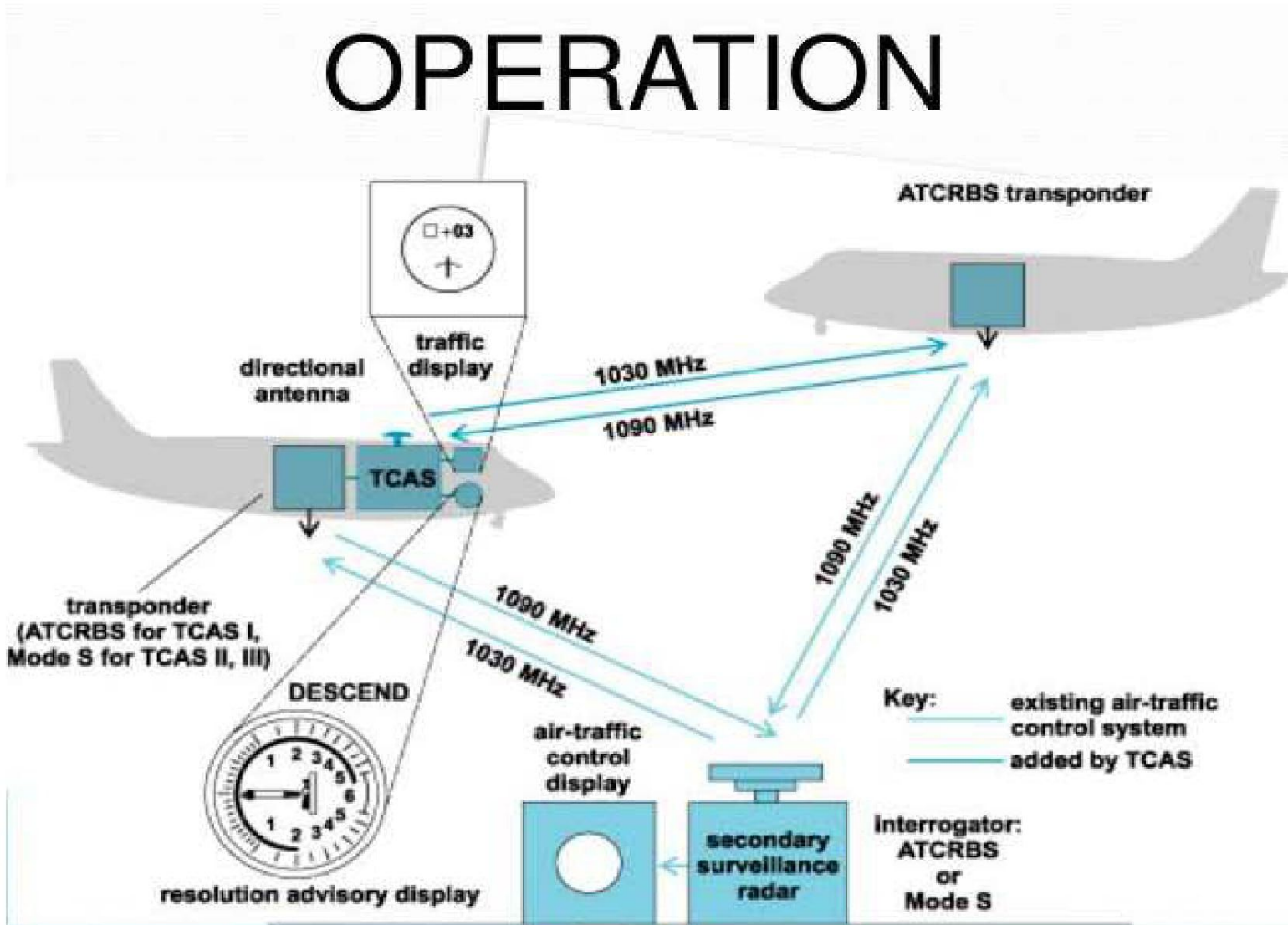


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- **Special codes are used in emergency, as follows:**
- ✓ Currently there are systems such as Airport Surface Detection Equipment–Model X (Airport Surface Detection Equipment, Model X (ASDE-X) and Advanced Surface Movement Guidance and Control System which use transponder returns from both aircraft and of airport service vehicles with installed transponders to improve safety and efficiency the surface movement control.
- ✓ A number of large airports have included information in the Automatic Terminal Information Service (ATIS) broadcasts when the transponder is required to be active for taxi operations.
- ✓ Furthermore at certain airports, a locally-optimised mix of available technologies, i.e. airport Multilateration, Surface Movement Radars and Automatic Dependent Surveillance Broadcast (ADS-B), enables A-SMGCS systems and integrated airport operations.



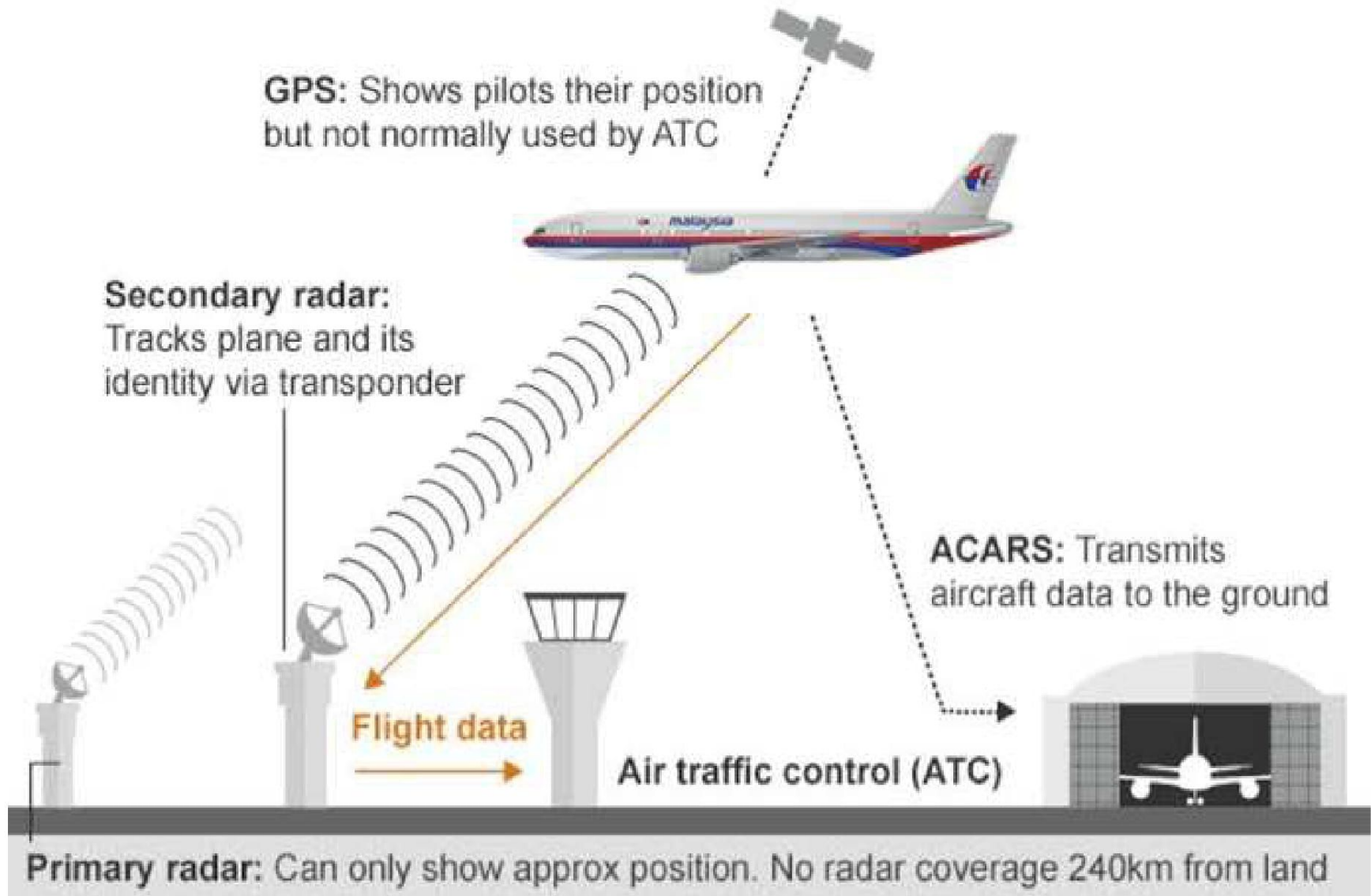
# ➤ AIR TRAFFIC CONTROL TRANSPONDER OPERATION



# ➤ **AIR TRAFFIC CONTROL TRANSPONDER**

- ✓ This could include the availability of suitable display of surveillance information on a consolidated display in the form of a moving map in flight decks and in surface vehicles.
- **Mode A, C, S and Ident**
- ✓ Civil aircraft may be equipped with transponders capable of operating in different modes:
  - Mode A equipment transmits an identifying code only.
  - Mode C equipment enables the ATCO to see the aircraft altitude or flight level automatically.
  - Mode S equipment has altitude capability and also permits data exchange.
- ✓ Mode C or S equipment is a mandatory requirement for

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✓ Transponders have an “Ident” facility which causes the aircraft radar response to stand out when the pilot operates the Ident switch in the cockpit. This should only be operated upon ATC request.

## ○ **Transponder Use in ATM**

✓ Transponders are used in ATM for various purposes, the most notable of them being:

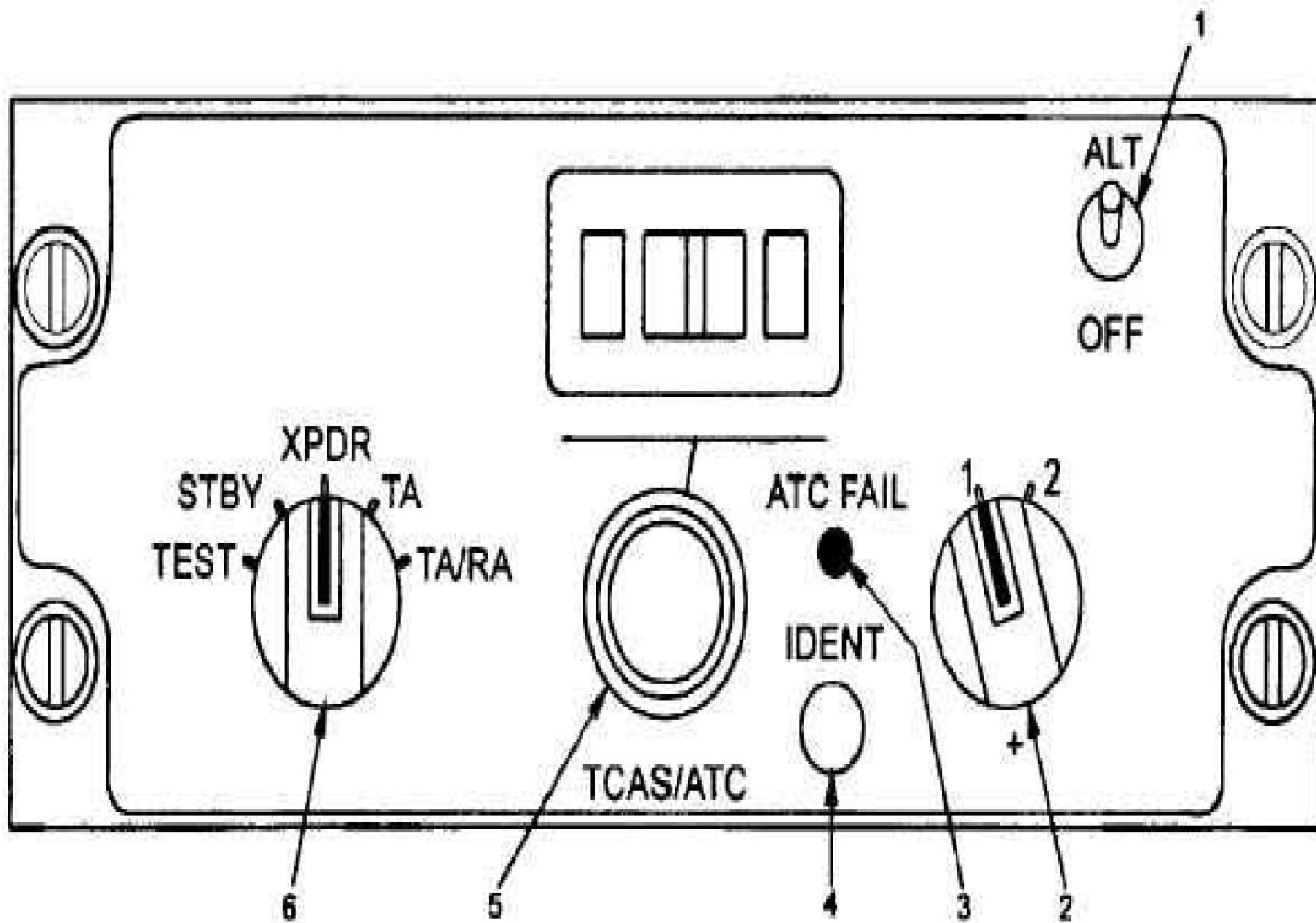
-Aircraft identification;

-Enhancing the controllers' situational awareness;

-Development of ATC tools and safety nets (e.g.

AMAN, MTCD, STCA, etc.).

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## ○ Transponders and ACAS

- ✓ Airborne Collision Avoidance System (ACAS) operation requires that both aircraft - the interrogator and the target - are equipped with operating transponders.
- ✓ An aircraft equipped with ACAS will receive the following information depending on the type of transponder with which the target aircraft is equipped:

Target aircraft equipped with:	Interrogator aircraft equipped with ACAS:
Mode 'A' transponder only	Will not track the target
Mode 'A/C' transponder with no altitude reporting	Below FL 155: Receives Traffic Advisory (TA) only (no altitude or trend arrow will be shown) Above FL 155: Will not show the target
Mode 'C' or 'S' transponder	Receives TA and vertical Resolution Advisory (RA)
ACAS	Receives TA and coordinated vertical RA

# **SECONDARY SURVEILLANCE RADAR**

A surveillance radar system which uses transmitters/receivers (interrogators) and transponders.



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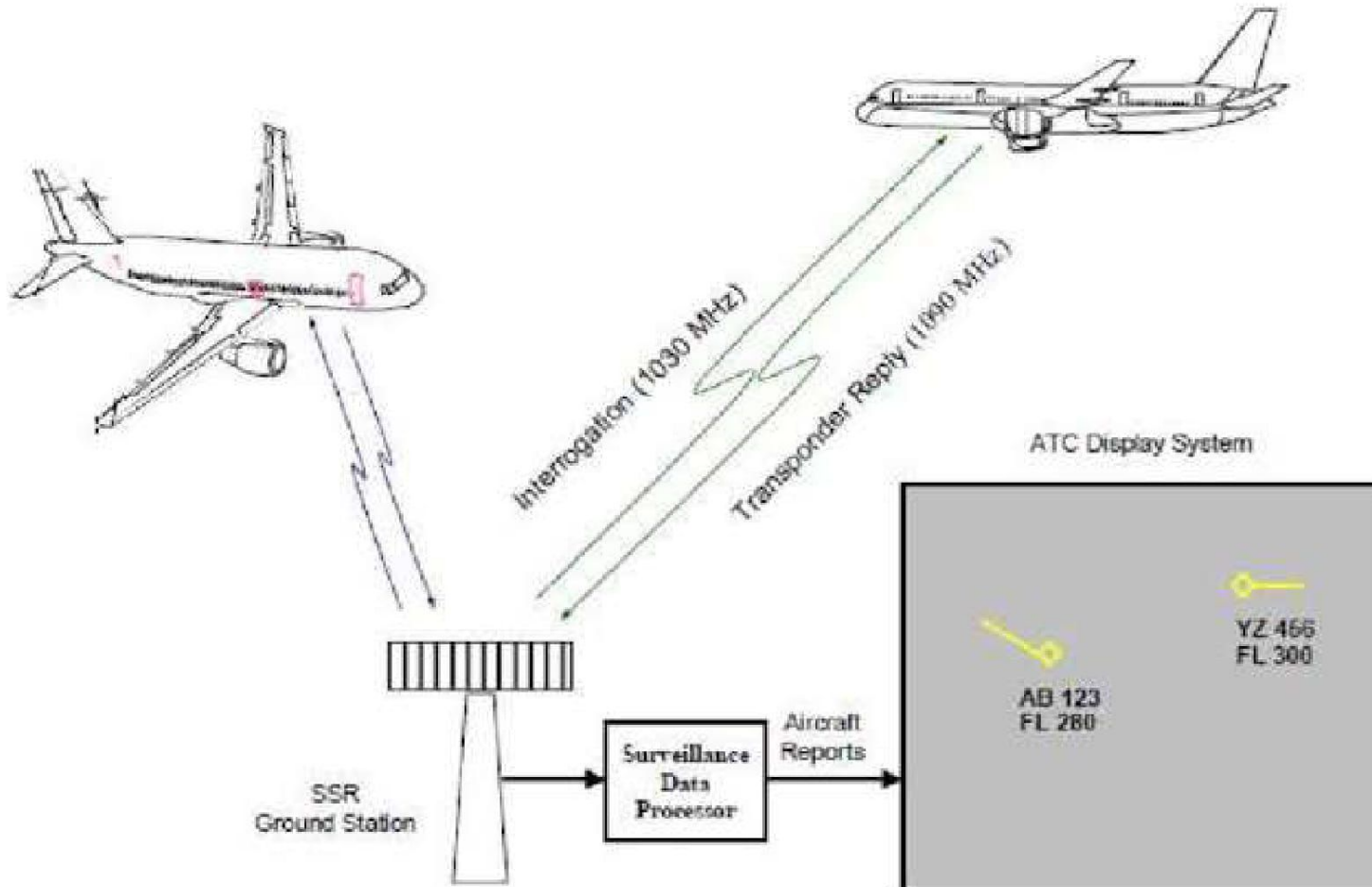
### ○ **Principle of operation**

- ✓ The radar antenna rotates and transmits a pulse which is received by the onboard equipment (transponder).
- ✓ The transponder sends back a reply containing at least a code (if operating in Mode A) but more often this is combined with level (mode C) or other information, e.g. aircraft identification, selected level, etc. (Mode S).
- ✓ The information received depends on the interrogation mode (A, C or S) and the transponder capability.
- ✓ For example, interrogation in Mode A will receive a reply in mode A even though the transponder may have Mode C or Mode S capability and an interrogation in Mode C will not trigger a response from a Mode A transponder.



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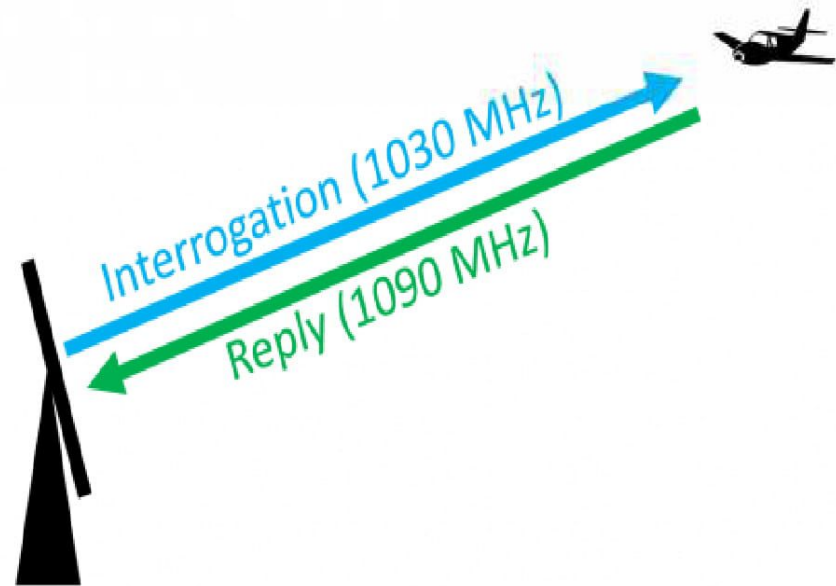
## ○ Principle of operation



# ➤ **SECONDARY SURVEILLANCE RADAR**

## ○ **Principle of operation**

- ✓ Typically, two Mode A interrogations are followed by a Mode C interrogation.
- ✓ The reason for using Mode A more frequently is that the identity of the aircraft (the SSR code) is of greater importance to the controller<sup>r</sup>



# ➤ **SECONDARY SURVEILLANCE RADAR**

## ○ **Principle of operation**

- ✓ Note that the level received from the transponder is always in respect to standard pressure (1013.25 hPa, 29.92" Hg) regardless of the altimeter setting selected by the pilot.
- ✓ This is a mitigation against human error. As a result, when the controller observes that two aircraft are separated by 1000 feet, it means that this separation exists regardless of the altimeter settings of the two aircraft.
- ✓ When the reply is received, aircraft position (range and bearing) is determined.
- ✓ The range is calculated by knowing the time difference between the interrogation and the reply (the speed of propagation is the speed of light).
- ✓ The azimuth is taken from the antenna position.

# ➤ **SECONDARY SURVEILLANCE RADAR**

## ○ **Advantages**

- ✓ Requires much less power to achieve the desired range, in comparison to PSR.
- ✓ This is because the transmitted signal only needs to reach the aircraft, while the PSR needs to emit a signal strong enough to reach the aircraft and travel back to the antenna.
- ✓ The information provided is not limited to range and bearing from the antenna but also includes additional data based on the transponder mode of operation (A, C or S).
- ✓ Targets are easier to distinguish due to the different SSR codes.
- ✓ SSR is immune to clutter as it uses different frequencies for interrogation (1030 MHz) and replies (1090 MHz).