SECONDARY RADAR - DISTANCE MEASURING EQUIPMENT (DME)

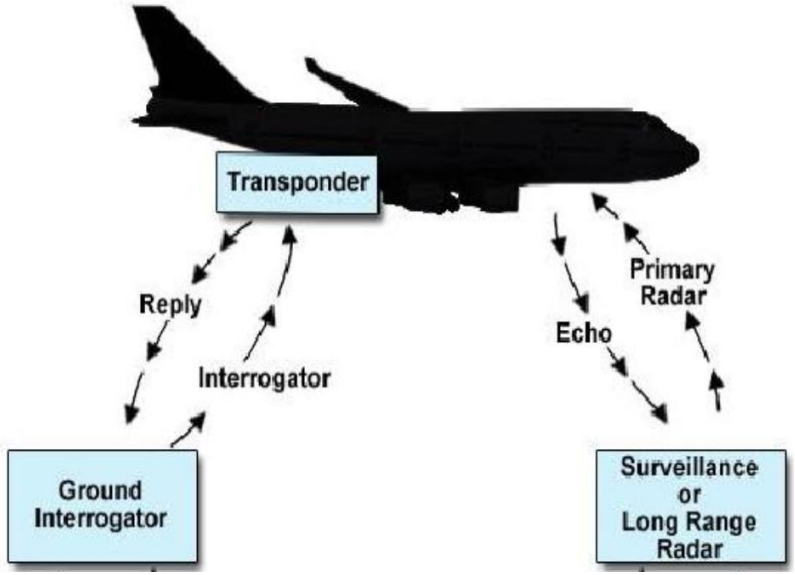
ECE 514 – RADAR & SATELLITE ENGINEERING

Monday, September 28, 2026

RECAP: PRIMARY Vs SECONDARY RADAR

1. **Primary radar** is a system where the ground-based antenna transmits a radar pulse, then listens for echo that is reflected from targets.

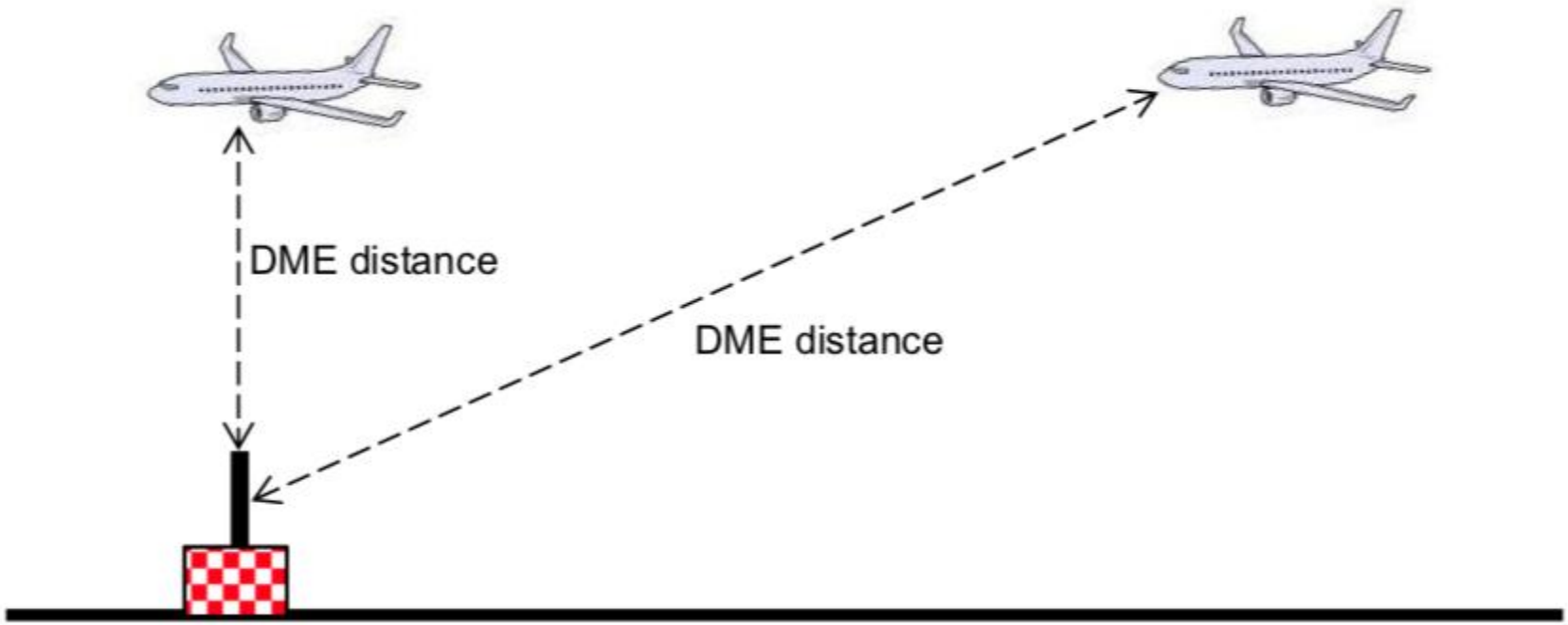
2. **Secondary radar** transmits pulses and receives digital data coming from the aircraft transponder. The transponder responds to interrogation by transmitting coded reply signal back containing information such as altitude, identification code etc.



(a) Secondary Radar (b) Primary Radar

DISTANCE MEASURING EQUIPMENT (DME DEFINITION)

- **DME (or Distance measuring Equipment)** is a transponder-based radio navigation technology used to display the slant range by timing the propagation delay of a UHF signal.



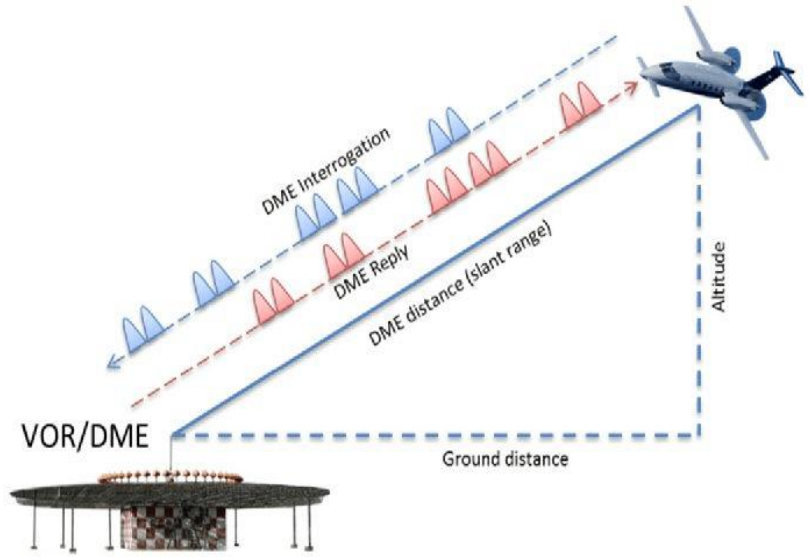
PRINCIPLE OF OPERATION (1)

1. Distance Measuring Equipment operates on principle of secondary radar.

2. A ground beacon continuously responds to trigger pulses received from airborne interrogators.

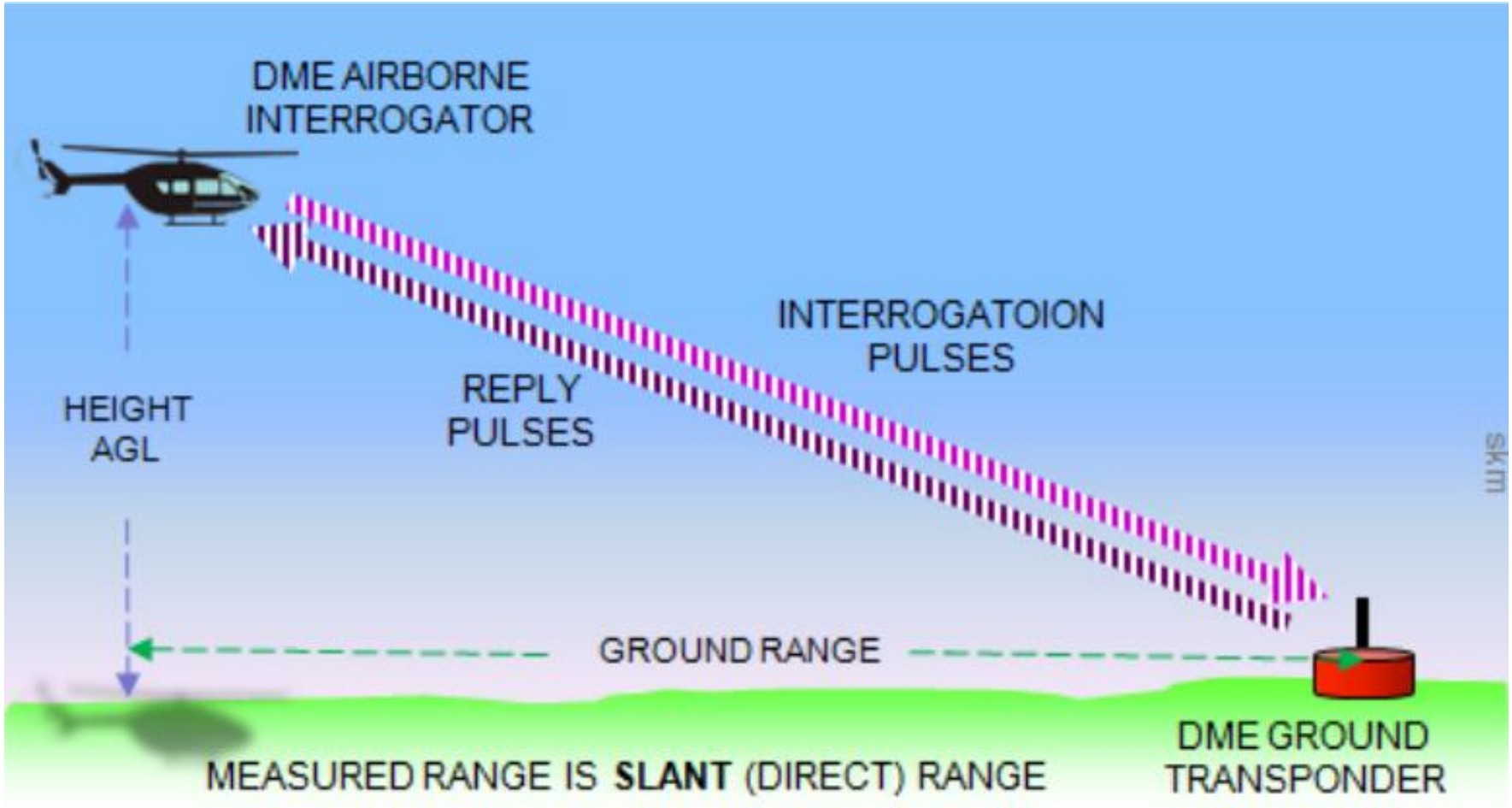
3. Airborne equipment receives all responses, determines the ones related to its transmissions and finds time delay between firing of interrogation pulses and corresponding reply pulses.

4. This delay is displayed as slant (direct) range at the airborne equipment as distance from the ground station.





PRINCIPLE OF OPERATION (2)



LOCATION OF DME EQUIPMENT

1. Ground transmitter beacons of DME are co-located with VHF Omni-directional Range) VOR equipment at all major aerodromes and enroute reporting points.

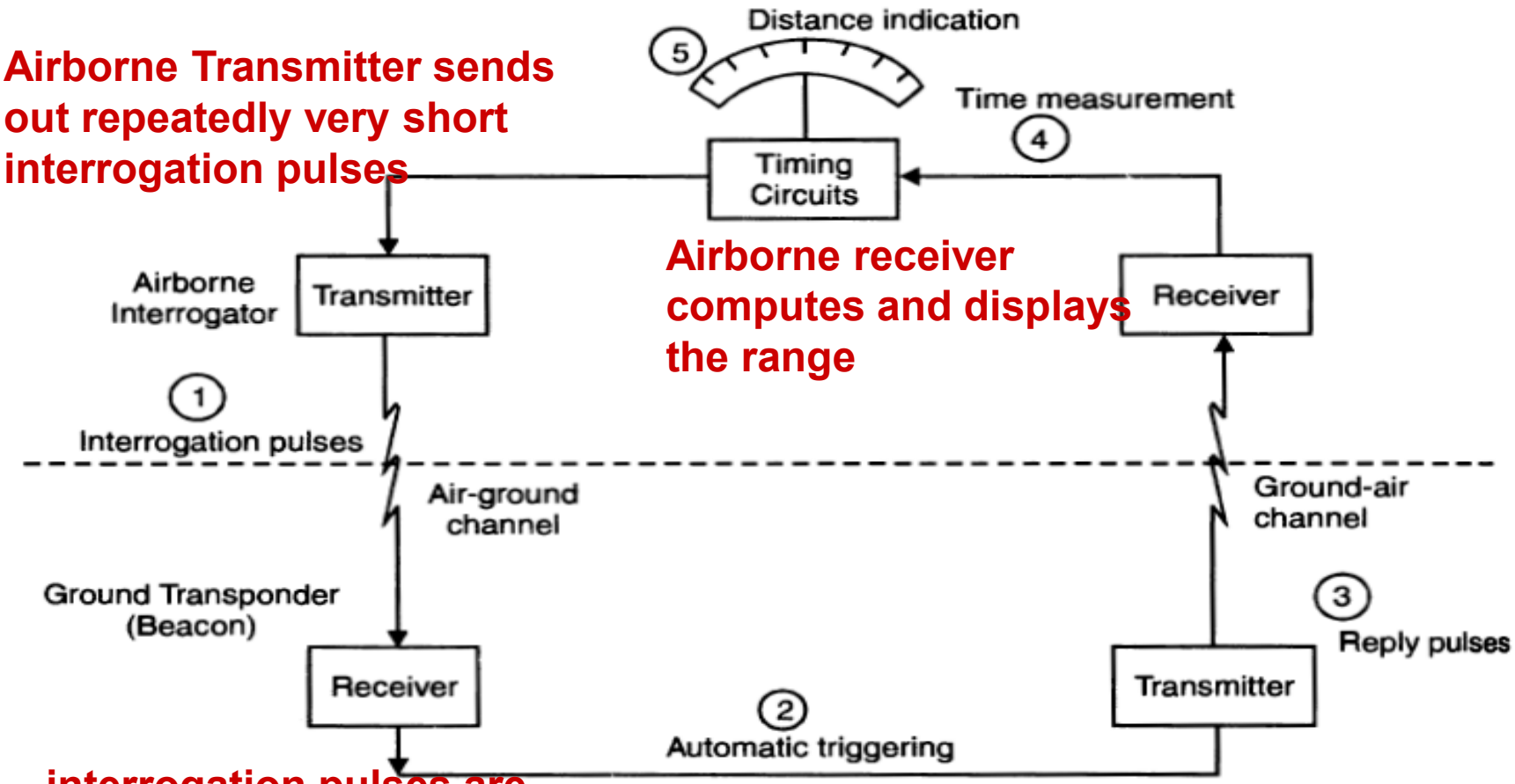


2. The system operates on frequencies between 960 MHz and 1215 MHz in the UHF band.

3. DME provides line of sight range.

4. Each ground station transmits its unique identification signal comprising three bytes.

BASIC BLOCK DIAGRAM OF DME SYSTEM



Airborne Transmitter sends out repeatedly very short interrogation pulses

Airborne receiver computes and displays the range

interrogation pulses are picked up by Ground Transponder

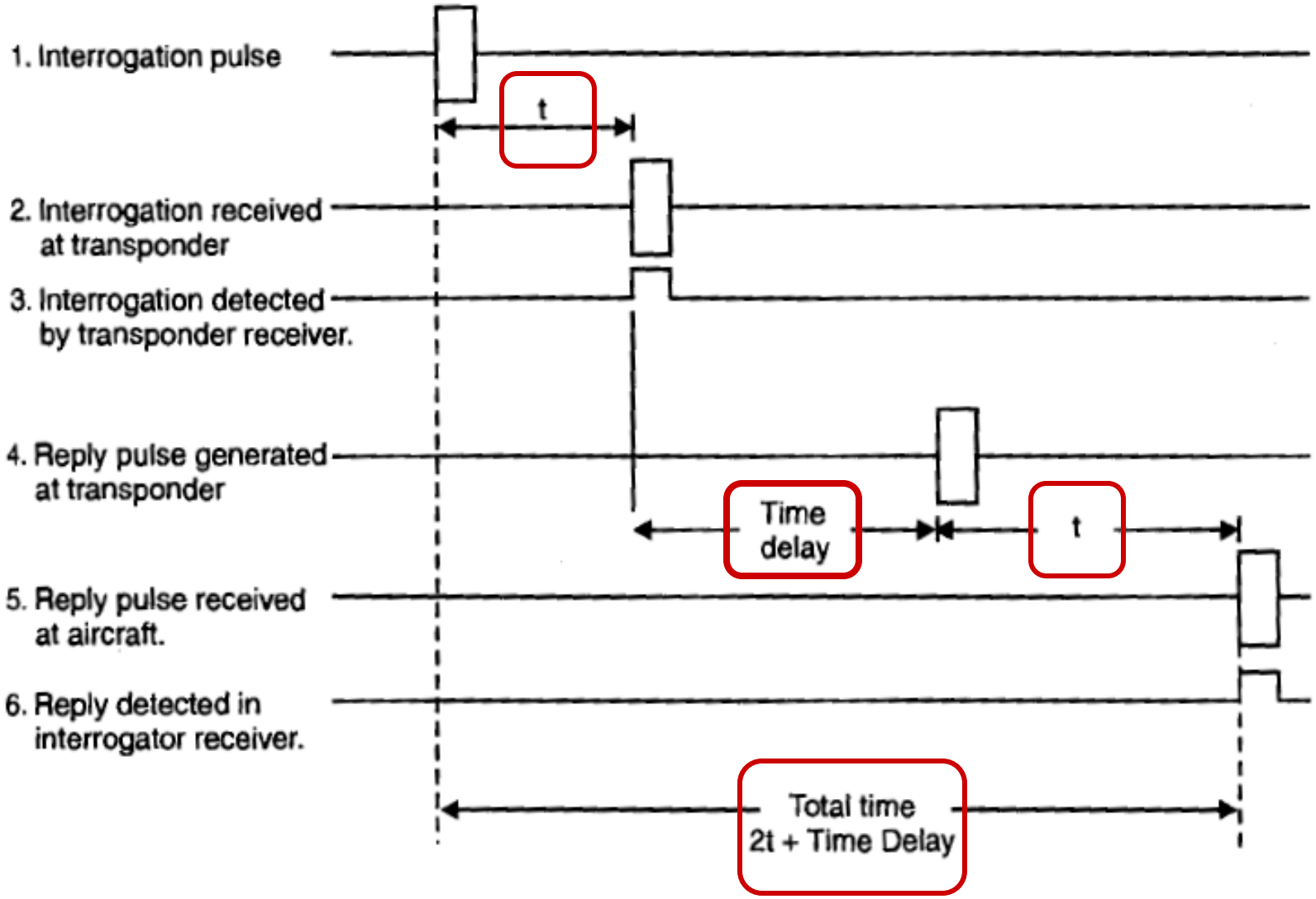
Transponder Responds with reply pulses

DME MODES OF OPERATION

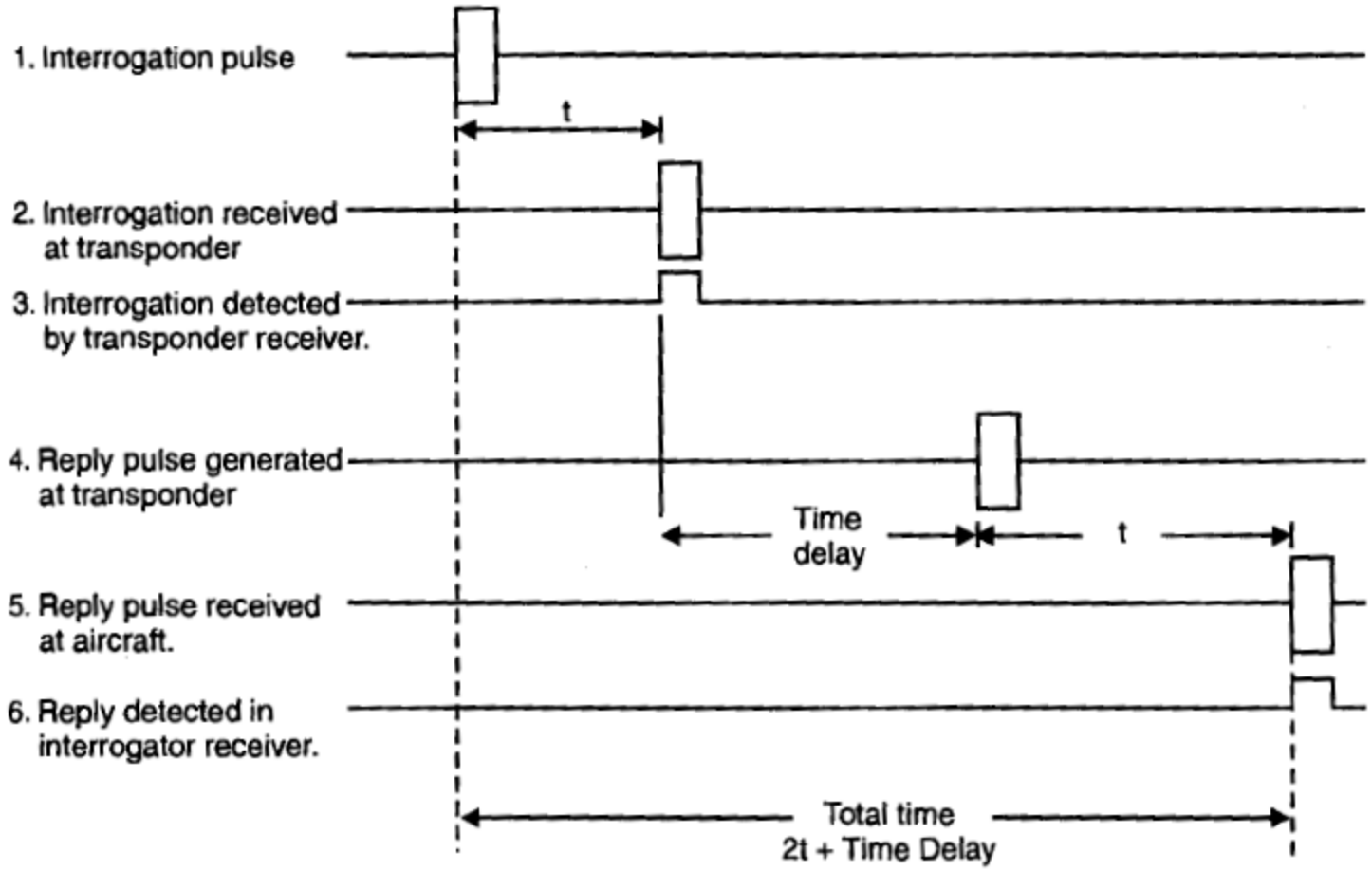
- **SEARCH MODE:** DME transmits interrogates at a higher rate typically 150 per second

  When Aircraft receives at least 65% replies, it changes to Track Mode.
- **TRACK MODE:** Interrogation rates reduce to approximately 30 per second.
- This allows more aircrafts to use the DME near airports.

SYSTEM TIMING



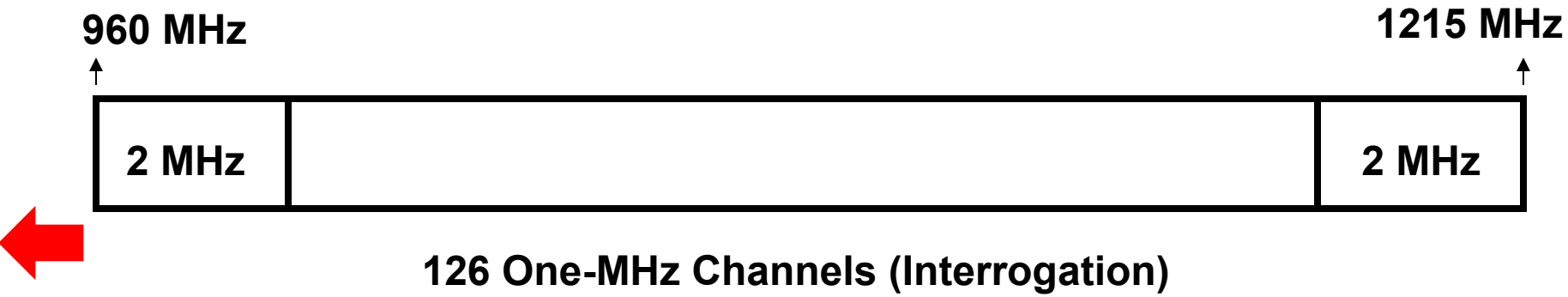
RANGE CALCULATION



Range, R = c x (2t–t_d)

DME FREQUENCY RANGE

- DME frequency band: 960 – 1215 MHz
- Lowest operating Frequency – 962 MHz
- Highest Operating Frequency – 1213 MHz
- Guard Bands of 2 MHz on either side.

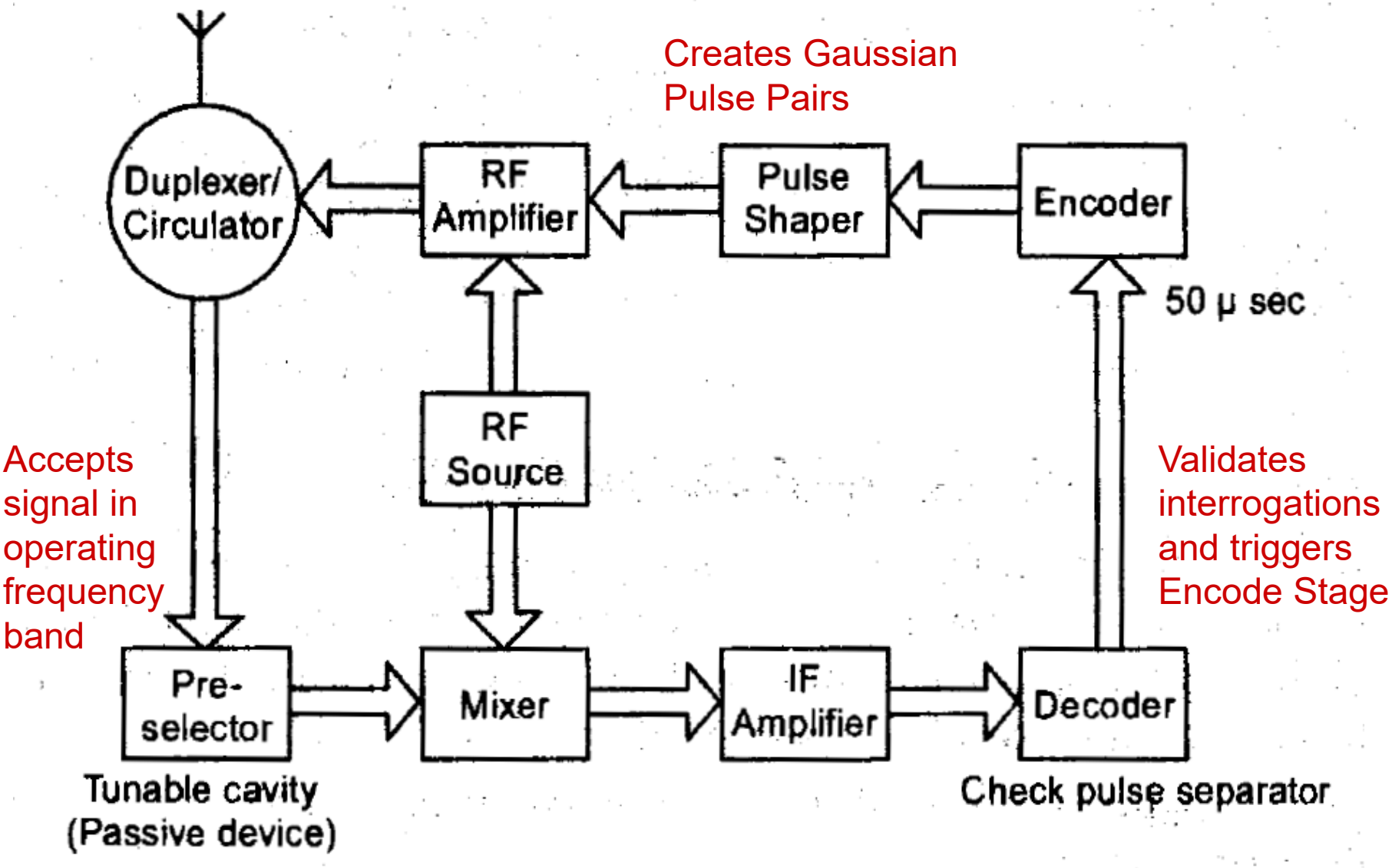


126 One-MHz Channels (Interrogation)

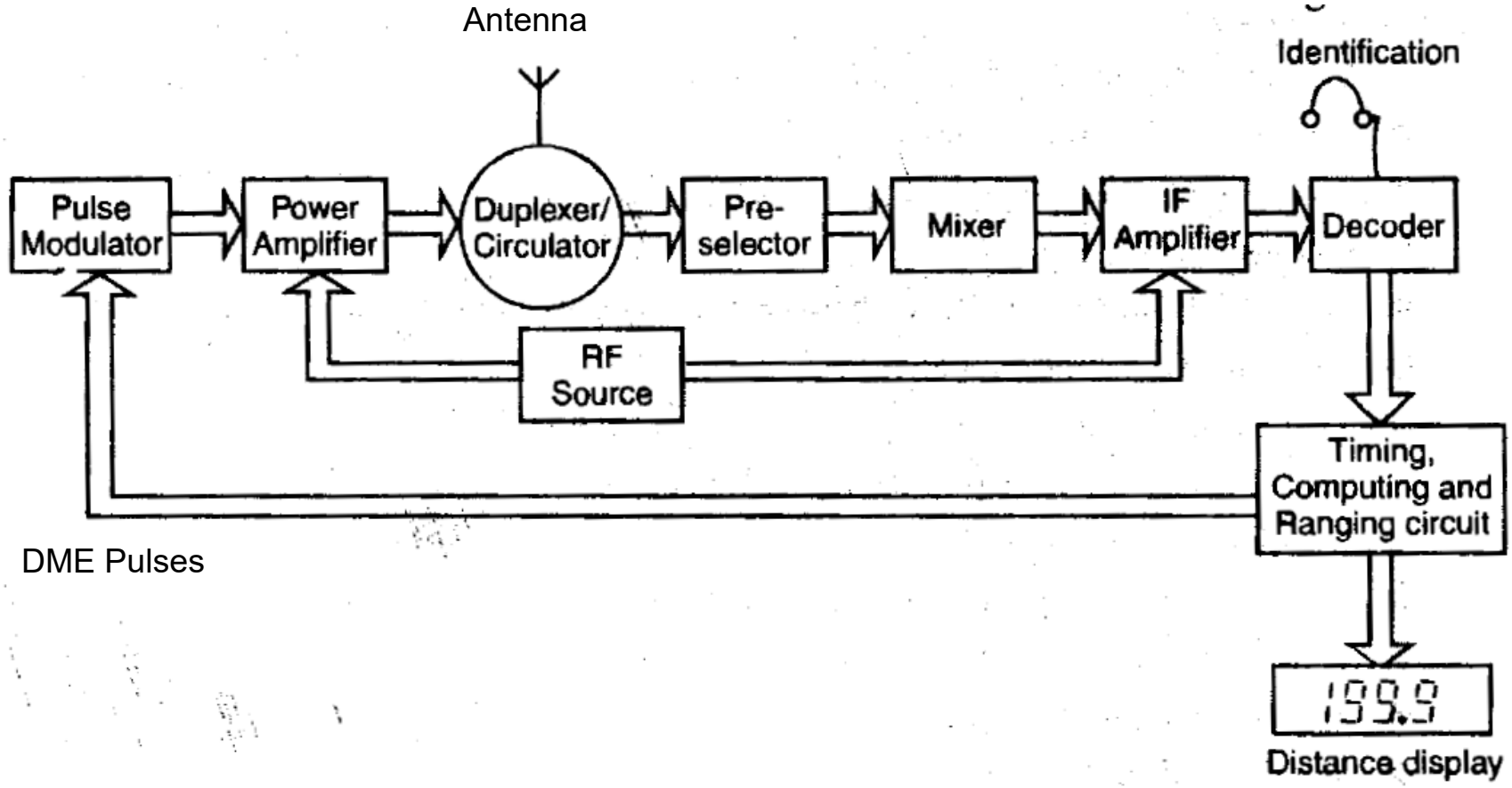
126 One-MHz Channels (Transponder Replies)

GSM Downlink

BLOCK DIAGRAM OF TRANSPONDER



BLOCK DIAGRAM OF AIRCRAFT INTERROGATOR



SLANT VS GROUND RANGE

- Flying overhead DME station will not indicate zero range, but the height above ground as the distance to beacon.

