

# Consideration of Radar Performance Issues

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**Radar coverage within a specified airspace shall be defined as being achieved when the **detection**, **quality** and **availability** performance requirements are satisfied.**



Coverage is mainly dependent upon:

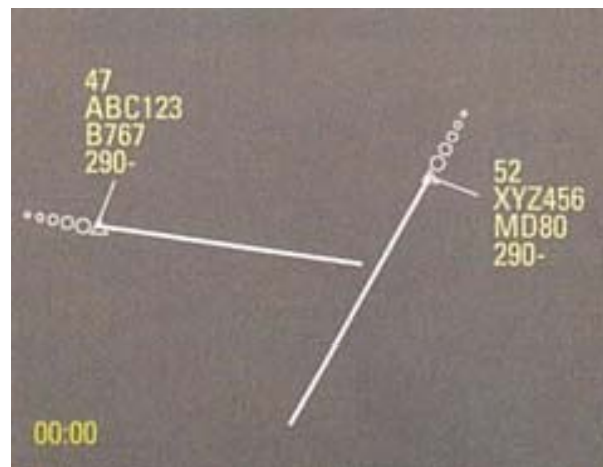
- a) siting;
- b) transmitter power;
- c) antenna type (gain, pattern);
- d) pulse repetition frequency (or the interrogation repetition frequency for the SSR);
- e) receiver sensitivity;
- f) extractor/processing system; and
- g) the aircraft transponder performance (for SSR)

Detection performance is defined in terms of:

- a) target horizontal position determination;
- b) false target reports;

also for SSR only:

- a) multiple target reports; and
- b) code detection (identification and height).



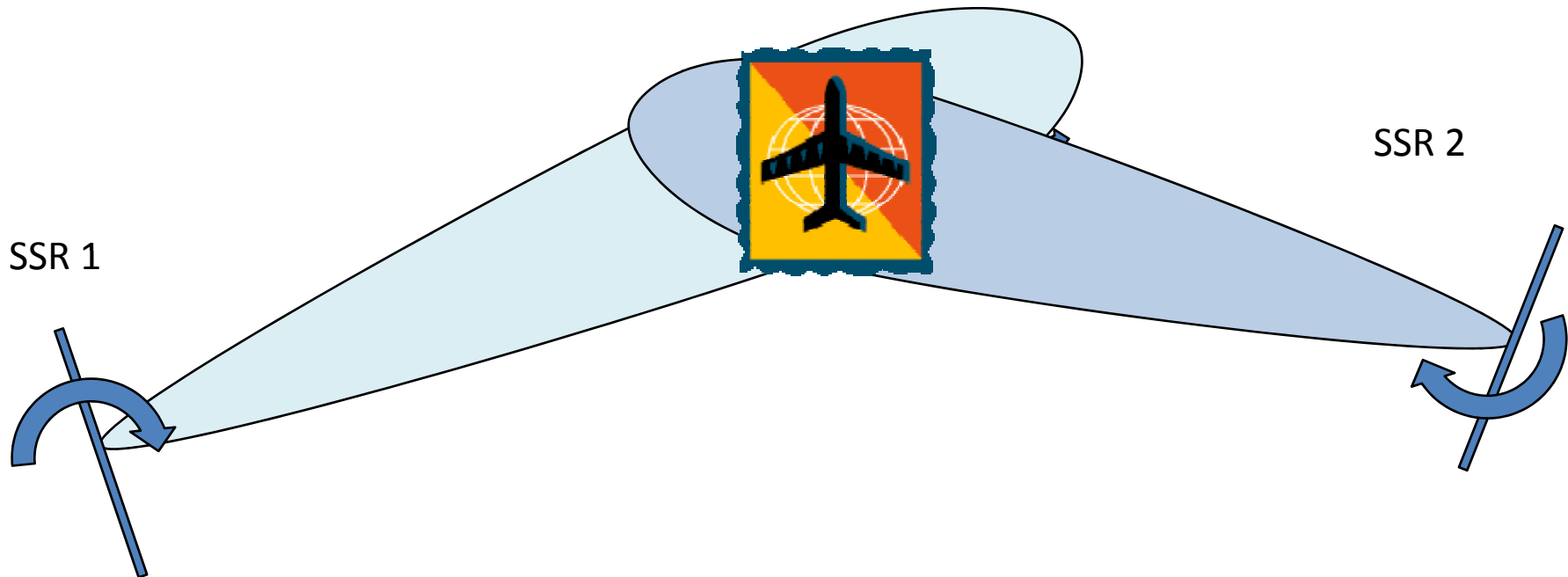
## Target Position Detection Probability

the probability that for a given aircraft, at each scan, a radar target report with positional data is produced.

## False Target Reports

- \* False PSR target reports may also be generated by weather, terrain, noise, clutter and other reflecting objects
- \* SSR target reports generated by one or more of the following:
  - asynchronous fruit;
  - synchronous fruit;
  - second time around replies.

# Asynchronous & Synchronous FRUIT



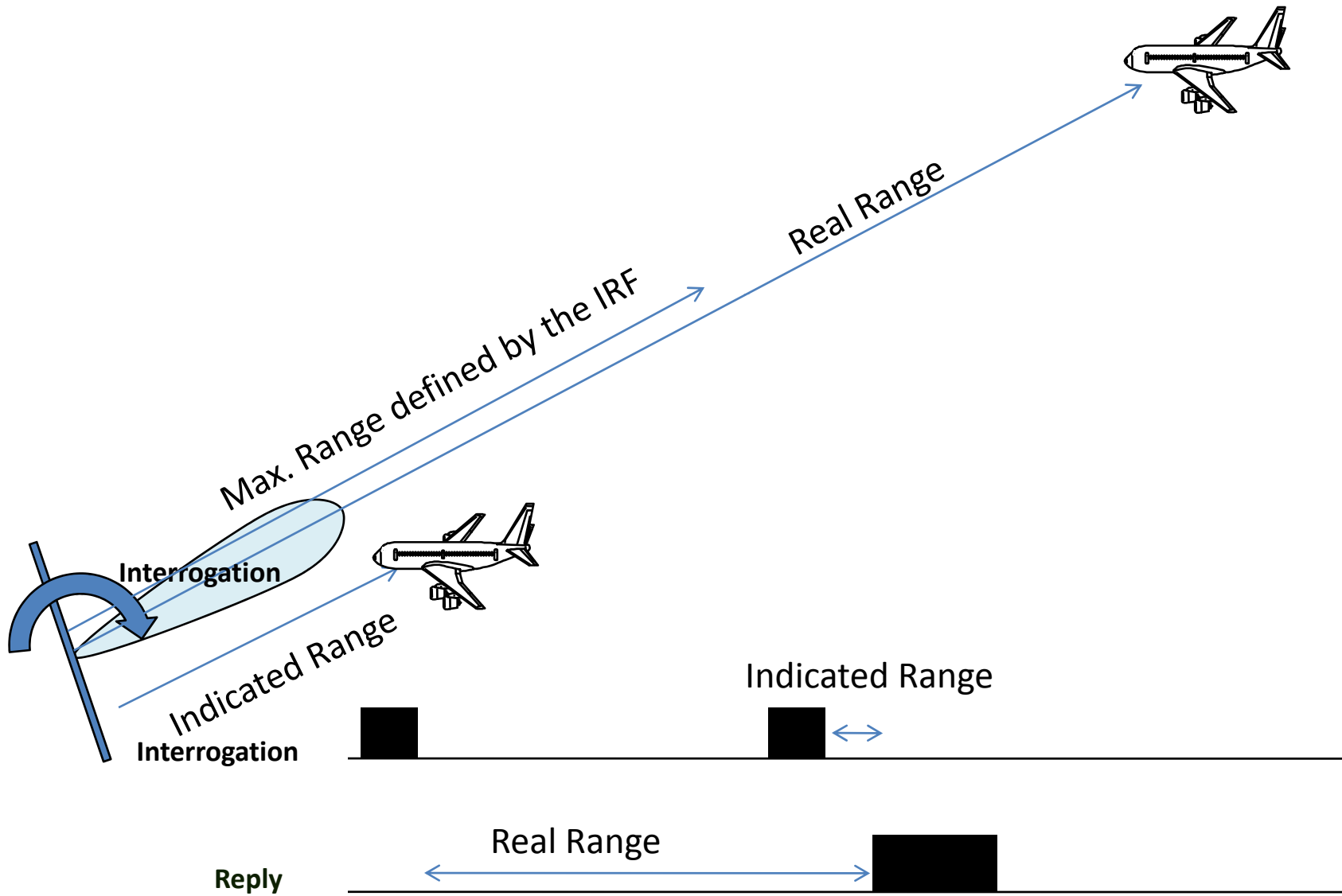
The aircraft reply to SSR 2 is FRUIT to SSR 1 and can result in a false target report

\* if both SSRs have the same IRF, FRUIT is synchronous (more serious)

\* if the two SSRs have different IRF, FRUIT is asynchronous (i.e. doesn't last)

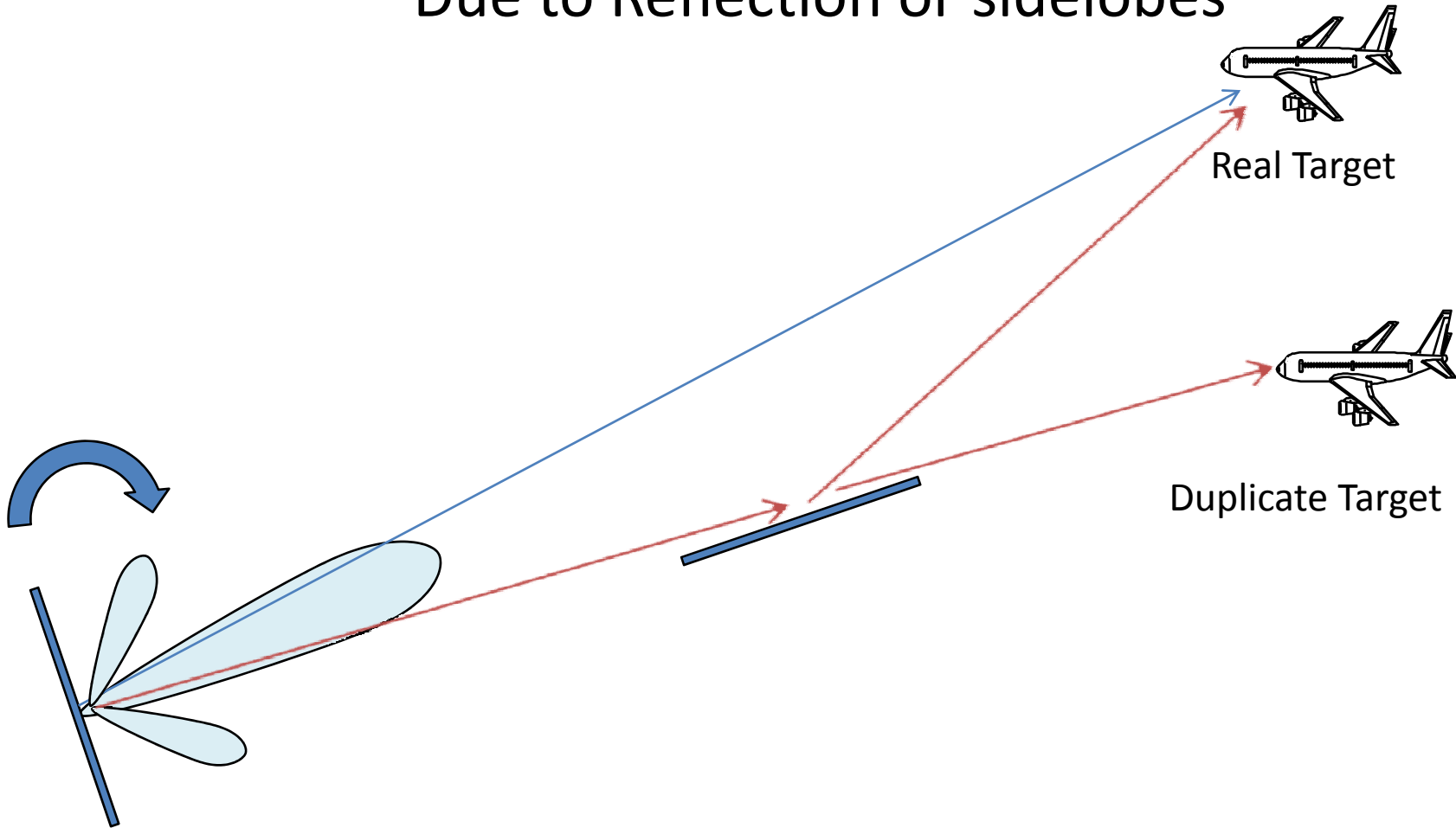
**Adjacent SSRs should always have slightly different IRFs!**

# Second-time-round false target



# SSR Multiple Targets

Due to Reflection or sidelobes





## The code detection performance

### **Expressed by:**

- overall Mode A probability of code detection;
- overall Mode C probability of code detection.

**the probability that, at each scan, for a given aircraft, a radar target report with correct validated code data, corresponding to the interrogation modes, is produced.**

## Quality

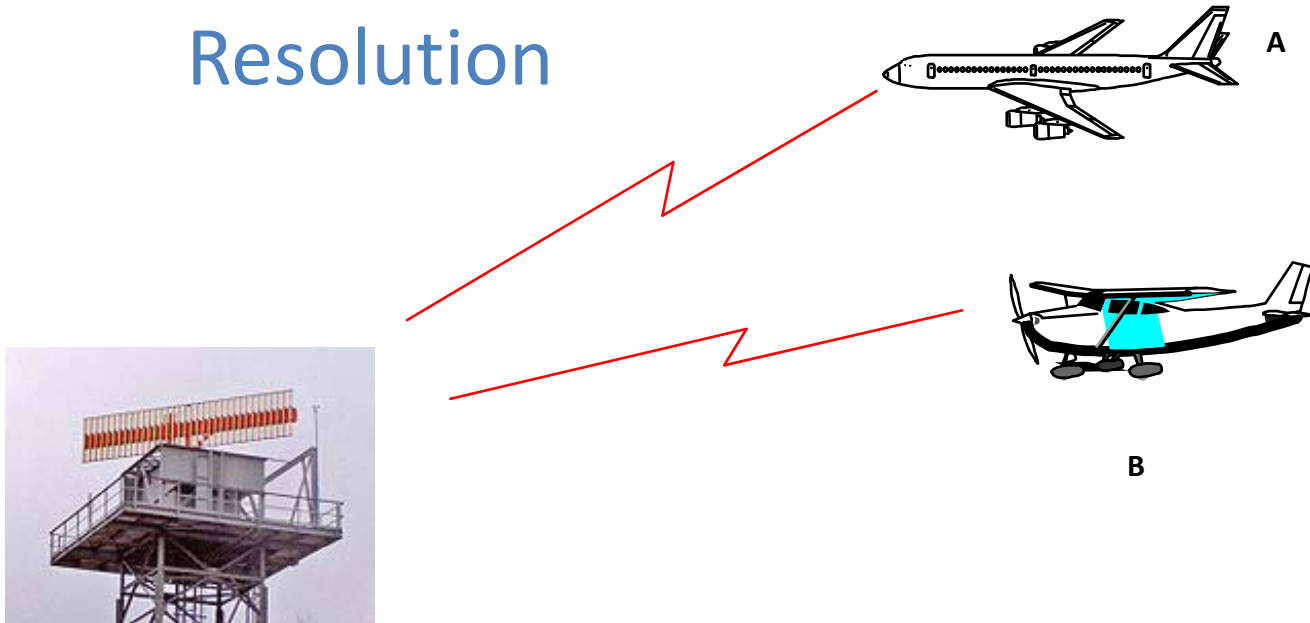
- The quality of the data provided is expressed as: ·
- positional accuracy;
  - false code information;
  - resolution.

Positional accuracy is the measure of the difference between the position of a target as reported by the sensor and the true position of the target at the time of detection.

The positional accuracy performances is expressed in terms of positional errors categorised as follows:

- **systematic errors**  
(slant range bias, slant range gain error, azimuth bias and time stamp error)
- **random errors** (Standard deviations of range and azimuth errors);
- **jumps** (target reports with positional errors higher than  $1^\circ$  in azimuth or 700 m in range)

# Resolution



Aircraft are considered in close proximity when their distance in slant range and azimuth are within the following limits:

- SSR:

slant range:  $\leq 2$  NM

azimuth:  $\leq 2 \times$  nominal 3 dB interrogation beamwidth

- PSR:

slant range corresponding to:  $\leq 2 \times$  nominal (compressed) pulse width

azimuth:  $\leq 3 \times$  nominal 3 dB beamwidth

## Availability

The availability of the data is expressed by the following characteristics:

- maximum outage time due to any given failure;
- cumulative outage time due to all failures over a period of one year;
- outage times due to scheduled action

A sensor is considered unavailable if no radar target reports, including field monitor(s) are produced for more than 2 antenna scans.

## Other performance factors

### \* PSR/SSR Data Combining

Performance for PSR/SSR data combining is defined by:

- overall probability of association;
- overall false association rate.

### \* On-Site Processing Delay

the time between the moment a radar target for a given aircraft is detected and the moment when the corresponding report starts to be transmitted

## *Typical (reasonable) Performance Requirements for SSR Sensors*



### ***Target Position Detection***

*Overall probability of detection: > 97 %*

### ***False Target Reports***

*Overall false target report ratio: < 0.1 %*

### ***Multiple SSR Target Reports***

*Overall multiple SSR target report ratio: < 0.3 %*

### ***Code Detection***

*Overall Mode A probability of code detection: > 98 %*

*Overall Mode C probability of code detection: > 96 %*

## ***Typical (reasonable) Performance Requirements for SSR Sensors (continued)***

### **Quality Requirements**

#### **Positional Accuracy**

##### *Systematic errors:*

- *slant range bias: < 100 m*
- *azimuth bias (degree): < 0.1°*
- *slant range gain error: < 1 m/NM*
- *time stamp error: < 100 ms.*

##### *Random errors (standard deviation values):*

- *slant range: < 70 m*
- *azimuth (degree): < 0.08°*

##### *Jumps:*

- *overall ratio of jumps: < 0.05 %*

#### **Resolution (depends on specific operational environment)**

##### **False Code Information**

- *Overall false codes ratio: < 0.2 %*

#### **Availability Requirements**

##### **The requirements for outage time are:**

- *Maximum outage time  $\leq$  4 hours*
- *Cumulative outage time  $\leq$  10 hours / year.*



## *Typical (reasonable) Performance Requirements for PSR Sensors*

### **Target Position Detection**

*Overall probability of target position detection: > 90 %*

### **False Target Reports**

*Average number of false target reports per antenna scan: < 20*

### **Quality Requirements**

#### **Positional Accuracy**

*Systematic errors:*

- slant range bias: < 100 m*
- azimuth bias: < 0.1°*
- slant range gain error: < 1 m/NM*
- time stamp error: < 100 ms.*

*Random errors (standard deviation values):*

- slant range (m): < 120 m*
- azimuth (degree): < 0.15°*

#### **Resolution (depends on specific operational environment)**

#### **Availability Requirements**

#### **Requirements for outage time are:**

Maximum outage time :  $\leq 4$  hours

Cumulative outage time :  $\leq 40$  hours / year



## Typical (reasonable) performance requirements for PSR/SSR Data Combining



### Plot/Track Association

- *Overall probability of association :  $\geq 95\%$ .*
- *Overall false association ratio :  $\leq 0.1\%$ .*

### On-Site Processing Delay

The maximum target report delay :  $\leq 2$  seconds

**Thank you for your attention**