RADAR SERVICES

1. Introduction

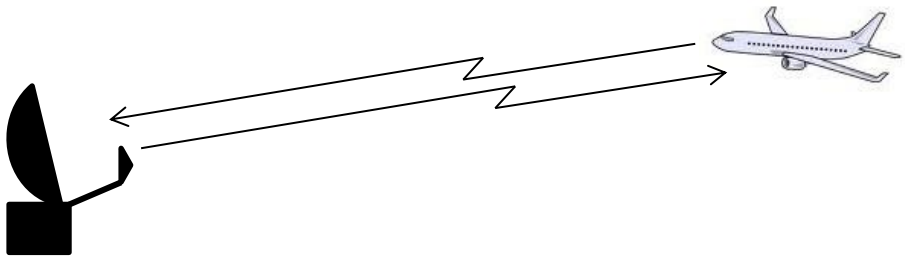
Air traffic control radars are devices used to detect, monitor and guide aircraft within a delimited airspace region.

Several types of radars are used in the framework of civil or military air traffic control.
In IVAO, we have only one Radar system simulated by IvAc software.

1.1. Primary radar

This type of radar operates using the electromagnetic waves properties, especially the echo.

The primary radar is a turning antenna that emits electromagnetic pulses, meaning a wave front concentrated in time which propagates through air and is reflected by all targets with sizes greater than a given threshold. The radar finally detects the incoming waves after their reflection.



The time difference between the pulse emission and the reflected wave reception is proportional to the distance of the target with respect to the emission antenna. The position of the antenna at the reception, corrected by the fact the antenna is continuously turning, is linked to the azimuthal angle of the target.

Primary radars are unable to detect the altitude of the target.

The emission power of the radar is one of the main specifications which determine the maximum detection range (radar coverage). The introduction of the pulse compression technique has made possible a global reduction of the instantaneous emission power, leading to less expensive devices.

Primary radars are placed in strategic positions within a given region to ensure the largest coverage:

- **Approach primary radars** are located in most of the airports to detect all aircraft flying within and in the vicinity of the airport airspace, in particular those which are not equipped with a transponder.

- **En-route primary radars** are meant to detect all aircraft in transit over a large airspace. They do not exist anymore in Europe since they are very power consuming and heavy to maintain. En-route primary radars have been replaced by secondary radars which are by far much more efficient.

- **Ground primary radars** are also located in some airports to help the controller in regulating the circulation of all vehicles, aircraft or others, within the tarmac and taxiways. This type of radar is useful especially in low visibility conditions.

1.2. Secondary radar

This type of radar operates using the interrogation technique.

The secondary radar transmits a series of electromagnetic pulses, but these pulses are coded in such a way that a transponder system installed inside aircraft system can detect and interpret them.

The transponder of an aircraft detects and decodes the radar pulses (interrogation signal) and emits a series of pulses which code the answer to the interrogation.

The secondary radars operate in “active mode” with respect to primary radars which operate in “passive mode”.

The passive answer (primary mode) of the aircraft provides its position while the active answer of the transponder (secondary mode) provides other information (code, altitude, speed…), depending on the type of both the radar and the transponder.

Two types of secondary radars exist:

- **Mode C** (or standard) **secondary radar**: it is used to interrogate aircraft on their transponder code (mode A) and the altitude indicated by their altimeter (mode C).
- **Mode S secondary radar**: it is an evolution of the standard secondary radar and is able to:
    - Make a selective interrogation of all aircraft equipped with mode S transponders and provide data exchange between the aircraft and the radar
    - Provide better data integrity by parity check
    - Provide a more precise altitude information

In IVAO, IvAc software can be considered as Mode S secondary radar.

1.3. Radar used by air traffic control (real aviation)

Radars are able to detect and localize all aircraft within an airspace region.

Radar echoes (eventually coupled to active answers) of a moving aircraft constitute an ensemble of “radar plots” which allow reconstructing a “radar track”.

Radar tracks are compiled to generate and display the radar image of the aircraft. All radars placed within a given region have overlapping coverage in order to avoid dead zones. Each of the radars available generates its own image of the aircraft track.

In order to avoid redundant plots in the process of track generation, all radars transmit their plots to a centralized computer which builds up the track.
So, the radar image of an aircraft is often produced by the combination of plots coming from several radars, thus ensuring a higher confidence of the displayed information.

In IVAO, we do not have this complex system, IvAc software makes a perfect view of all aircraft plots without any combination of radar images.

2. Radar services

Radars are used by air traffic control to provide three **types of radar services:**

- Radar Surveillance
- Radar Assistance
- Radar Guidance

Radar services can be provided only to aircraft which are “**radar identified**”, which means that the correlation between the radar track and the aircraft is unambiguous.

Some air traffic control units are not able to provide some of the radar services because of their radar performances or the airspace configuration.

2.1. Radar Surveillance

Radar is used to identify and determine the position of all aircraft.

In this framework, radar surveillance is meant to:

- Monitor the separation between each aircraft flying within a controlled airspace where radar separation is provided
- Monitor the position of each aircraft within a controlled airspace where traffic information is provided
- Monitor non-controlled aircraft evolution
- Monitor any significant deviation from the instructions cleared by the controller to the pilots (if applicable)

Pay attention, this service has no communication with the aircraft.

2.2. Radar Assistance

Radar is also used to provide assistance to all aircraft.

In particular, it helps the controller to:

- Provide any information about traffic position and intention, meteorological conditions
- Provide information about any significant deviation from the instructions cleared by the controller to the pilot, or the published flight plan given by the pilot, in particular concerning the correct route and flight level to be flown at.
- Provide necessary assistance and information in case of pilot assistance request, pilot decision to land in alternate aerodrome or in case of emergency.

Pay attention, this service does not give any clearance or instructions to aircraft. The air traffic controller only gives advices, information to help the pilot to make a decision.

2.3. Radar Guidance

Radar is finally used to guide aircraft within a controlled airspace. In particular, it helps the controller to:

- Provide vectors to aircraft in order to ensure their separation and/or make them follow a specific trajectory
- Optimize and regulate the traffic flow (minimize trajectory, avoid level flight, handle level crossing, etc.)

2.4. Radar services provided by each ATC position

On IVAO, all controllers dispose of a radar when using IvAc radar client.
Nevertheless, the radar services that can be provided by the ATC depend on the control position he has in charge:

ATC position	Radar surveillance service	Radar assistance service	Radar guidance service
DEL	NO	NO	NO
GND	YES	PARTIALLY	PARTIALLY
TWR	YES	YES	PARTIALLY
APP	YES	YES	YES
DEP	YES	YES	YES
CTR	YES	YES	YES
FSS	YES	YES	NO

Other ATC positions can be exceptionally opened in the case of specific events (mostly VFR based):

- **AFIS** (**Aerodrome Flight Information Service**) agent at the **TWR** position: in general he does not dispose of a radar and only provides **radar Surveillance and partial Assistance**
- **FIS** (**Flight Information Service**) agent at the **APP** or **CTR** position: in general he does dispose of radar and only provides **radar Surveillance and Assistance** (in some cases only partially).