# New radio direction finders boost aviation safety

Fig. 1:
Mast with R&S®DF-ATC-S direction finding system in weatherproof housing and R&S®ADD095 DF antenna.

Radio direction finders let air traffic controllers see more. They enhance the situational awareness by adding the dimension of radiocommunications – something that radar cannot detect. The new R&S®DF-ATC-S family of direction finding systems makes life easy for the operators and the ATC organization: All the equipment is mounted at the base of the antenna mast. The only infrastructure needed is the power and network connections.

The typical image of an air traffic control (ATC) workstation has the controller sitting in front of a screen where flight movements are monitored based on information provided by a radar system (Fig. 2). Aircraft in the controlled airspace use a radar transponder to automatically transmit a code that appears as a flight number or aircraft registration identifier at the appropriate position on the radar screen. However, the controller gets no visual identification of the aircraft that is currently calling. Analog aeronautical radio does not transmit any signatures in the background; otherwise, it would be possible to correlate the transponder data with the radio data. This means the identification process must be handled in some other way. For quickly and reliably recognizing the transmitting aircraft, radio direction finders determine its direction or position. They supply the data to the air traffic management system, which then displays it on the radar console – either using a beam if only a single direction finder is involved, or with a circle around the relevant flying object (Fig. 4) if it can be precisely located using a cross-bearing fix. Since the controller can receive a call from only one aircraft at a time, just a single aircraft is highlighted on the screen (assuming a cross-bearing fix), even though dozens of aircraft may be in the air. This allows the controller to immediately identify who is at the other end of the communications.

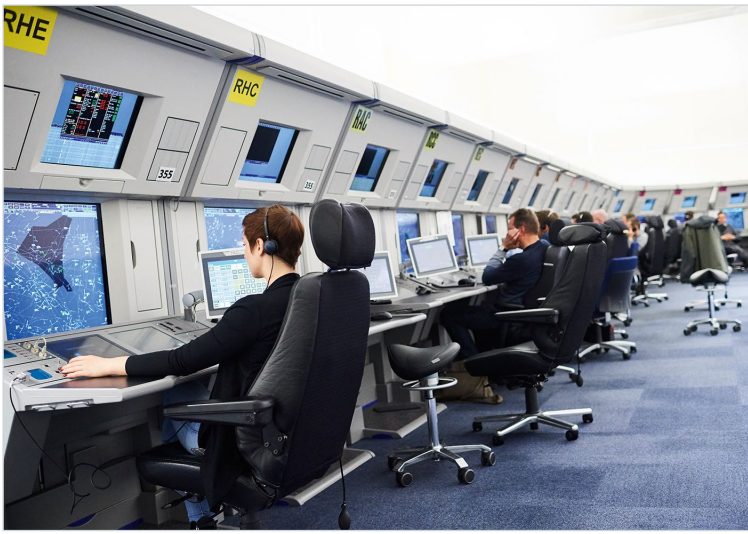


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Fig. 2: Air traffic controllers at Eurocontrol's MUAC (see box on page 81) see radio DF information superimposed on their radar screens.

Given that voice radio is used to manage the airspace, this information is critical for overall safety. If there is no radio direction finder to provide the necessary clarity and the controller mixes up the aircraft that is calling, a dangerous situation can quickly arise. This can happen if the call sign is misunderstood during noisy conditions. For example, the controller might give an inappropriate instruction to change flight levels, which in the worst case could have disastrous consequences.

However, radio direction finders not only provide support during arrivals and departures at major airports, they are also part of en-route control at supranational ATC organizations such as Eurocontrol (see box on page 81). At smaller airfields that lack radar systems, ATC direction finders are the only independent source of direction information. They assist flight control, which otherwise would have to rely solely on position reports from pilots in order to keep track of the situation.

Rohde & Schwarz has been building radio direction finding systems for over 60 years. One of the first was the NP4, which is seen here in an installation from the early 1960s.


Fig. 3: The flat system PC with touch panel is used for configuration and DF display. Flight control at small airfields (typically not equipped with radar) can see the direction of the aircraft that is currently calling on the polar diagram.

## Simultaneous direction finding on up to 32 channels

The new R&S®DF-ATC-S direction finding system (Fig. 1) covers all of the aeronautical radio frequencies. It can simultaneously determine bearings on up to 28 VHF channels and four out-of-band channels (up to 450 MHz, including the distress radio beacon on 406 MHz). The channels are easy to select using the software and can be modified at any time, assuming the operator has administrator privileges.

The R&S®ADD095 DF antenna functions on all channels with the same precision and sensitivity. The smaller and more economically priced R&S®ADD317 can even be used in semistationary applications.

If the direction finder is operated as a standalone system instead of with a radar console (e.g. at smaller airfields), the supplied system PC with touch panel is used as the DF display (Fig. 3). The user interface on the antiglare display has been reduced to the essentials to ensure intuitive operation. The display is also built for glare-free night viewing. In cases where the direction finder needs to be integrated into an air traffic management system, the open interfaces help ensure smooth integration.

The most striking feature of the new R&S®DF-ATC-S family is the compact, weatherproof housing. Besides the receiving unit with the DF processor, the housing also contains the DF server, the heating and cooling units, the GPS receiver and an IP switch. The direction finder is simply mounted at the base of the (optionally available) mast and connected to the power grid and data network. Four standard configurations are available to meet the needs of civil and military airfields, major airports and en-route control installations.

Herbert Stärker

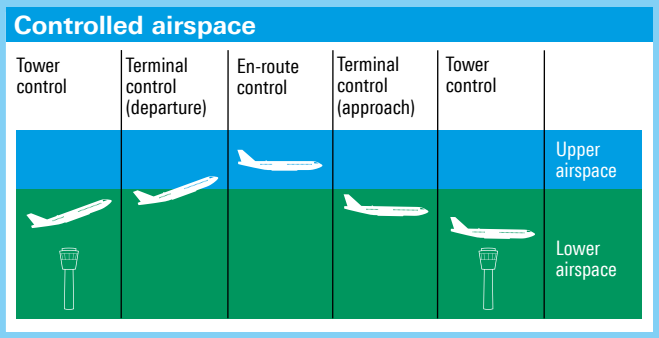
### Responsibilities within controlled airspace

Inside controlled airspace, pilots must obey the instructions issued by the ATC center that is currently responsible for their aircraft. However, just who is responsible depends on the flight phase and altitude. The actual structure and designations for the different ATC centers vary from country to country and region to region, but the rules are standardized worldwide.

Aircraft take off from civil or military airfields and airports. There, the pilots receive information, instructions and clearances from tower control. Tower control monitors take-offs and landings and manages all of the air traffic within its area of responsibility. As aircraft fly away from the airport or descend from cruising altitude, terminal control takes over coordinating them. Different frequencies, areas of responsibility and designations are often used for the approach and take-off as well as for the different directions to the airport.

Finally, area control centers guide aircraft along their designated route through upper airspace. Since aircraft typically pass through airspace managed by different area control centers, they are handed over from one ATC center to the next along their route.

The different air traffic controllers in charge of this process use voice radio to coordinate the traffic. Normally, they can determine the position of aircraft near the airport using approach radar and further away using en-route radar. During each flight phase, controllers must manage the separation between aircraft in compliance with the applicable minimum horizontal and vertical distances. The radio direction finders help by providing additional information.



## More safety above the clouds

To improve safety in air traffic control, Eurocontrol – a European organization with 41 member states working in the area of air traffic safety – uses seven radio direction finders from Rohde & Schwarz. Air traffic controllers at the Maastricht Upper Area Control Center (MUAC) have been using this technology since 2017 to help them keep better track of current flight movements. MUAC is operated on behalf of four countries. It monitors the upper airspace (over 24 500 feet or about 7500 meters) of Belgium, Luxembourg, the Netherlands and northwest Germany. With more than 1.77 million flights passing through the area controlled by MUAC annually, the organization handles the third-largest traffic volume in Europe.

The direction finders are distributed across northwest Germany, Belgium and the Netherlands. Their multichannel design allows them to simultaneously cover all of the frequencies in use and continuously supply DF data to MUAC. There, triangulation software is used to determine the positions of the transmitting aircraft. The results are shown to the responsible controllers along with the data from the radar system in the form of a circular mark on the screen (Fig. 4).

The locations of the direction finders were determined with the aid of the R&S®PCT propagation calculation tool (Fig. 5). This simulation software calculates the optimal direction finder locations, taking into account the required coverage and the propagation conditions. For reliable position fixing, it must be ensured that at least two direction finders can simultaneously receive each aircraft in the area of responsibility in a reliable manner.

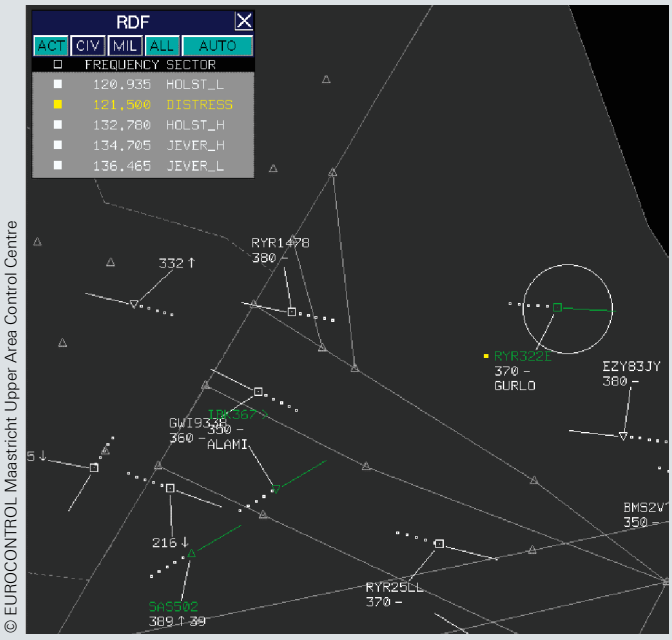



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Fig. 4: The aircraft that is currently calling is marked on the radar screen with a circle for reliable identification.

Fig. 5: The R&S®PCT propagation calculation tool helps determine suitable sites for direction finding locations.