Help in the urban jungle: reliable direction finding in urban areas

Many users of radio direction finders are familiar with this effect: Despite using advanced DF equipment, direction finding often does not produce satisfactory results in urban areas. This is due to a constant fluctuation in the direction displayed on the azimuth polar diagram. Numerous publications have examined the problem of direction finding in urban areas. The underlying issue is related to the phenomenon of multipath propagation. For this DF problem, Rohde&Schwarz has now developed a convenient solution that allows even inexperienced users to reliably determine the direction of the emission of interest.

Direction finding in urban areas

In an environment with numerous obstacles such as an urban area, a radio direction finder is confronted with the phenomenon of multipath propagation. Due to reflections of radio waves on building facades and other obstacles, the radio direction finder receives wave components from completely different directions in addition to the direct incident wave from the direction of the radio transmitter (Fig. 1). In many cases, the direct path from the direction of the radio transmitter to the direction finder is also obstructed so that the bearing is computed primarily based on reflected radio waves. This can result in the bearing display fluctuating to some extent. These fluctuations continue while the DF vehicle is in motion. Nevertheless, experienced operators can in many cases determine a direction trend and approach the source of the radio signal. However, the direction of travel must sometimes be changed completely because the detected strong signal was actually a reflected signal component. Overall, this is a time-consuming process that demands a certain level of experience.

An intelligent solution: Even inexperienced users can reliably locate the emission of interest

The new Mobile Locator function provided by the R&S®RAMON Locate software now allows users to elegantly solve this problem. As soon as the DF vehicle begins moving and the new function is activated, current bearings are recorded. After a certain time, the software uses a special algorithm to compute, based on the recorded bearings, a geographical area in which the radio transmitter is most likely located. The software overlays this area in the digital map in the R&S®MapView application in the form of a probability map with color shadings (Fig. 3). This provides the operator with an initial indication of the direction and place where the radio transmitter of interest might be located. During ongoing travel in the DF vehicle, the software continues making emitter location computations using newly obtained bearings until after a while it displays the emitter location in the form of a red circle on the map (Fig. 2). The radio transmitter has now been located with relatively good accuracy and can be approached with the vehicle for closer investigation. What's best about this? The new function is so intelligent and convenient to use that even untrained or inexperienced users can still reliably determine the location of an emission of interest.

Applicable signals and surroundings

Mobile Locator was developed to locate a radio signal on a fixed frequency. A change in the center frequency of the radio direction finder outside the currently set DF bandwidth automatically leads to a restart of the computational algorithm. The software is used on mobile platforms such as vehicles in conjunction with only a single radio direction finder.

Fig. 1 Due to multipath propagation in urban areas, the vehicle receives the radio signal of interest from multiple directions.

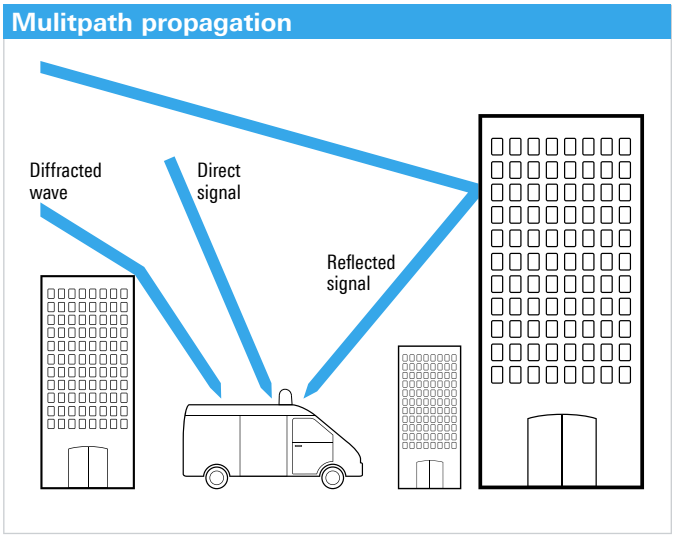

Fig. 2 Map display with R&S®MapView in the DF vehicle. The yellow circle indicates the vehicle's current position while the black line shows the current line of bearing. The red circle indicates the computed location of the radio transmitter. The route of the DF vehicle is shown in purple in Figs. 2 and 3.

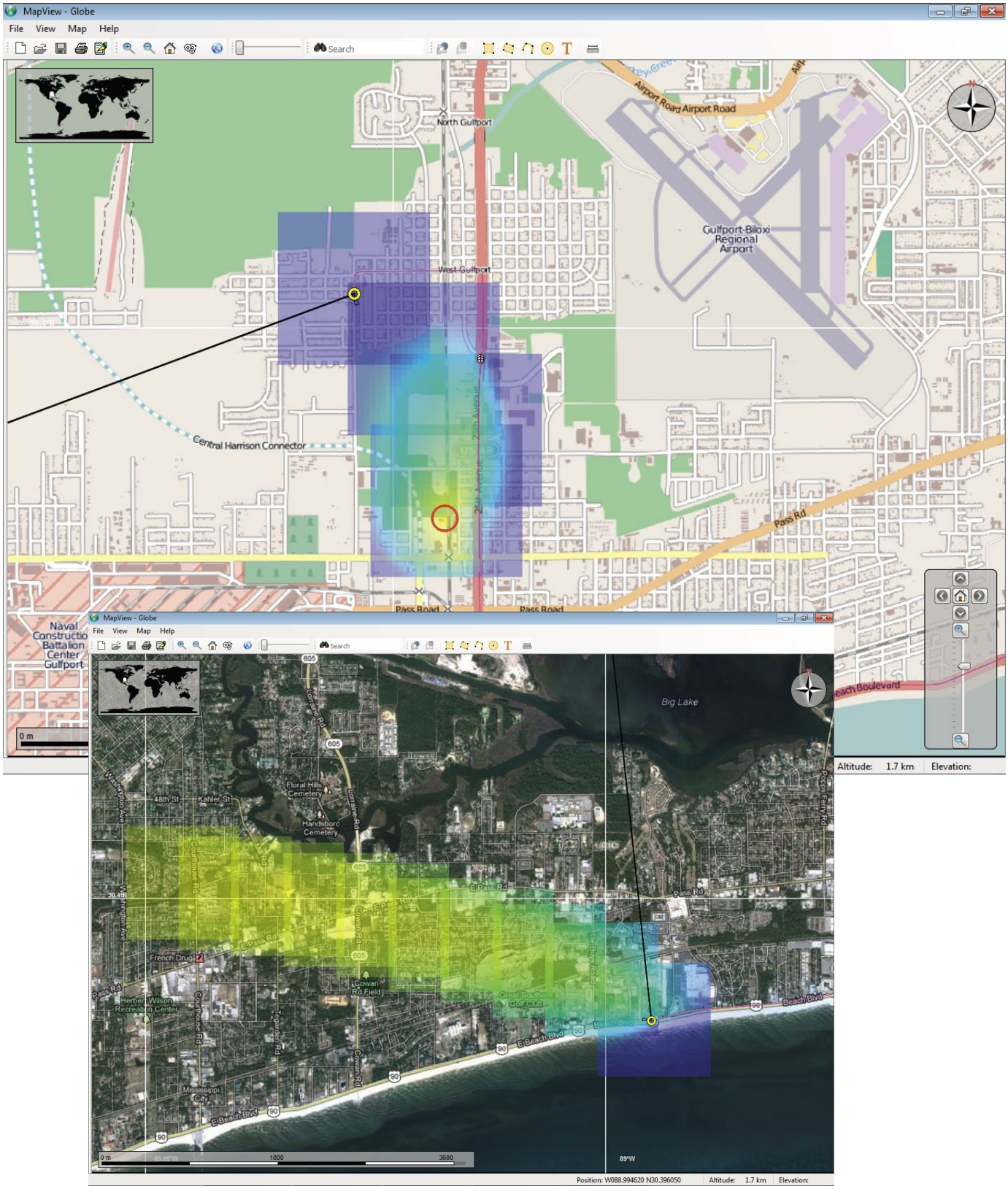

Fig. 3 Probability map overlaid on the digital map. The direction of the radio transmitter is clearly recognizable although its precise location has not yet been calculated. Once a consistent and stable computation of the emitter location is possible, it is displayed on the map. The probability map is continually updated.

The main focus during the design of the software was to ensure that even inexperienced users can rapidly and conveniently obtain correct DF results. Expert users can still customize certain Mobile Locator parameters to make special adaptations to suit the current geographical surroundings. One example is the scaling of the probability map, which is updated at selectable time intervals. Moreover, parameters such as the size of the DF data buffer used for computing the emitter location, values for starting the emitter location computation (triggers) as well as parameters that influence the consistency of the emitter location computation can be modified. Experienced users will quickly learn to modify the parameter settings in order to further improve the reliability of the computations.

For all radio direction finders from Rohde&Schwarz

The PC user interface included with every current radio direction finder from Rohde&Schwarz provides an interface to the Mobile Locator function and is available in all DF systems with the following radio direction finders: R&S®DDF007, R&S®DDF205, R&S®DDF255, R&S®DDF550, R&S®DDF0xE and R&S®DDF0xA.

Fig. 4 shows a vehicle equipped with the R&S®ADD107 compact DF antenna, which is attached to the vehicle roof using an adapter with magnetic mount. The direction finder is controlled via the PC user interface on a laptop, for example. The R&S®RAMON Basic, R&S®RAMON Locate and R&S®MapView software modules are installed on the PC. Once the software is started, reliable direction finding in urban surroundings is no longer a problem.

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Fig. 4 DF vehicle with the R&S®ADD107 compact DF antenna (20 MHz to 1.3 GHz) and the R&S®DDF007 digital direction finder (in vehicle, not visible).

Photo: Oliver Sichelschmid, Rohde&Schwarz