Networking digital direction finders for improving radiomonitoring efficiency and locating frequency-agile emitters

The rapidly increasing variety of communication media and growing shortness of suitable DF sites require wide-area networking of DF instrumentation and operator positions of large radiomonitoring systems. A condition for networking is that the detected data are reduced and processed at the DF site considering that an extremely large volume of raw data is obtained by the direction finder when frequency-agile signals and short-term emissions are monitored. Rohde & Schwarz has taken up this challenge with scanning and monitoring direction finders of the DDF (digital direction finder) family coupled with new software.

DF units

Digital Direction Finder DDF190 is a DF unit with antennas for monitoring and test receivers covering the frequency range 20 to 3000 MHz [1]. It allows bearings to be taken in line with ITU guidelines and offers a yet unrivalled combination of compact design, sensitivity and accuracy. System linkup is made via the RS-232 interface of the DF unit.

While DDF190 has been designed for direction finding of conventional signals with a dwell time of at least 30 ms, Digital Monitoring Direction Finders DDF0xM [2] allow also very short and wideband signals to be detected. Depending on the antennas and DF converters used, a frequency range from 0.3 to 3000 MHz can be covered in the fixed-frequency, search or scan mode. A built-in or external PC is used for control and result processing. System linkup is established by the two-stage adaptive data compression for each RS-232, Ethernet or ISDN interface of the PC section. Corresponding to the achievable data rate, only fixed-frequency operation is possible via RS-232 and telephone lines, while the connection via Ethernet or ISDN permits almost unrestricted operation also in the scan mode.

Digital Scanning Direction Finders DDF0xS (0.5 to 1300 MHz) are optimized for fast scanning and operation as automatic search tools in complex systems [3]. Multistage data compression provides the conditions required for integrating the DF tools via data lines at low operating costs.

Remote-control software DDFREMM

Software DDFREMM permits the graphical user interface (man-machine interface or MMI) of Monitoring Direction Finder DDF0xM to be set up detached from the direction finder and connected via common communication links (FIG 1). In addition to bearings the demodulated audio signal is transmitted. The available transmission bandwidth is optimally used so that even at low data rates full system operation and almost constant detection probability is achieved. Since one or several direction finders can also be remote-controlled from different operator positions, full-area direction finding can be performed with very few personnel. The position of the transmitter can be calculated from the bearings of several detached stations and marked on a digital map.

Location software DDFLOC

DDFLOC is a powerful, network-compatible software package of the RAMON (radiomonitoring) system family [4] for radiolocation applications. DDFLOC is used with Direction Finders DDF0xM and DDF190 in computer-controlled direction finding and location of HF, VHF and UHF signals for:

- radiolocation at single frequencies,
- automatic monitoring of frequency bands and frequency lists,
- result display on digitized map,
- preparation of reports for location results.

Detached DF stations are controlled by the system controller with the aid of serial interfaces (RS-232) normally via modems. Bearings and radiolocation results are entered online in geographical or UTM coordinates on a digitized map on the system controller monitor. A variety of auxiliary functions simplifies result evaluation:

- short-term history (display of last location results),
- position marking using icons, lines, areas and text elements,
- spherical triangulation,
- single-station locator (option for HF range),
- postprocessing of recorded results.

In a networked system, DDFLOC can be optionally used with other RAMON operator positions. Measurement results,
signal contents, location results, etc, can of course be administered in a data base.

With a local direction finder connected, system functions are available that cannot be used in detached direction finders, or with restrictions only, because of limited transmission capacity. In an unknown signal environment, first an overview of activities of interest can be obtained in the scan mode and displayed in different types of graphs. The user may then select a signal from this graphical overview and locate it using the fixed-frequency mode. Another possibility is to check a predefined list of frequencies or frequency ranges for activities (search) and then automatically trigger a bearing.

Location software SCANLOC

The radiomonitoring and location system SCANLOC, another powerful software package of the RAMON system family, is used with Direction Finders DDF0xS for interception and location of short, broadband and frequency-agile signals at HF, VHF and UHF. An accurately synchronized scan of all direction finders ensures high probability of acquisition and accuracy of results in the location of short-term emitters and frequency-agile transmitters, and permits realtime display of detected emissions on digitized maps. Time synchronization is achieved by means of GPS receivers. FIG 2 shows a simplified system comprising two stations. Detected emissions are pre-processed at the site of the detached direction finder and stored with time stamps. These data can automatically be called by the central DF station. With the use of powerful algorithms for data compression, all key information can be transmitted between direction finder and DF center at relatively narrow transmission bandwidths.

Results are graphically processed in the DF center and displayed on two screens. On one screen signal activities are displayed online in the form of different diagrams:

- signal activity versus time and frequency (waterfall),
- azimuth versus frequency,
- level versus frequency (RF spectrum).

On the second screen the detected signals are displayed on a digital map after processing (FIG 3). If desired, different bearings of a transmitter are automatically combined into plots containing all main signal parameters, e.g. the detected single frequencies of a hopping emitter. The movement of mobile transmitters can automatically be traced and stored. The system automatically recognizes known signals that are in a signal library and marks them so that new emissions can easily be identified.

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REFERENCES