Successful detection and identification of mobile interference

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The profusion of wireless technologies in use today inevitably leads to interferences, which disrupt services. Hence, governments, regulatory bodies and mobile operators focus on identifying and minimising sources of interference, some operators having dedicated staff to pin down illegal or unwanted signals, which is not a trivial process.

In a communication system, interferance is mostly seen as a receiver problem. This doesn't mean nothing ever bad happens at the transmitter side, but these issues are normally dealt with by the operators when troubleshooting their infrastructure. The receiver is more likely to be affected by interfering signals or increased noise levels which can desensitise receivers and make mobile phones, for instance, undetectable by their base stations.

Offender characterisation

Once interference is observed, it is crucial to understand its nature. Normally the signal is measured at ground level with an omnidirectional antenna. Its bandwidth, shape, frequency stability or drift, occurrence in time (over hours or days), behaviour (continuous or pulsed), modulation (or lack thereof), change in amplitude and so on, are all measured and analysed with a spectrum analyser. The instrument's "max hold" function sees the global bandwidth impacted by the interference, with the "save on event" masks recording all the occasions when a pre-set amplitude "envelope" mask is exceeded – especially by an intermittent or random signal. Once this information is recorded, events can be analysed more closely, potentially determining the interference's origins. In this complex process, user knowledge and experience are more valuable than any autonomous software.

The channel power function used to quantify the signal's amplitude needs to be set in the spectrum analyser. Where the interference drifts in frequency, the channel power bandwidth must be wider than the signal's bandwidth.

The spectrogram or "waterfall" display shown in Figure 1 is a very useful tool for recording all sweeps in the frequency band of interest; by colour-coding the amplitudes of the carriers present, it provides information on periodicity or frequency drift, for example.

Pre-drive requirements

For maximum efficiency, it is best to use filters to isolate the interfering frequency in the spectrum analyser; this prevents too many signals entering the equipment's input stage and avoids sorting through unwanted neighbouring signals.

If the interfering signal has been spotted from ground level, software tools like Anritsu's Mobile Interference Hunter system (which consists of a detecting antenna and associated instrumentation) are driven around the area of interest to quickly and efficiently locate the signal. Anritsu's software automates the interference-hunting process but still requires preparation.

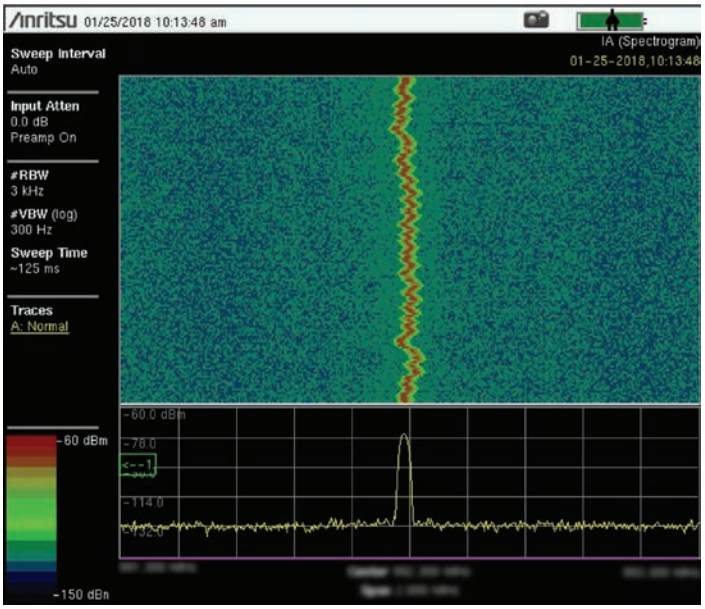


Figure 1: "Waterfall" display (spectrogram) showing frequency drift of a carrier

Inevitably there will be situations when the mobile interference hunting system can't exactly determine the interferer's location, such as in areas inaccessible to vehicles

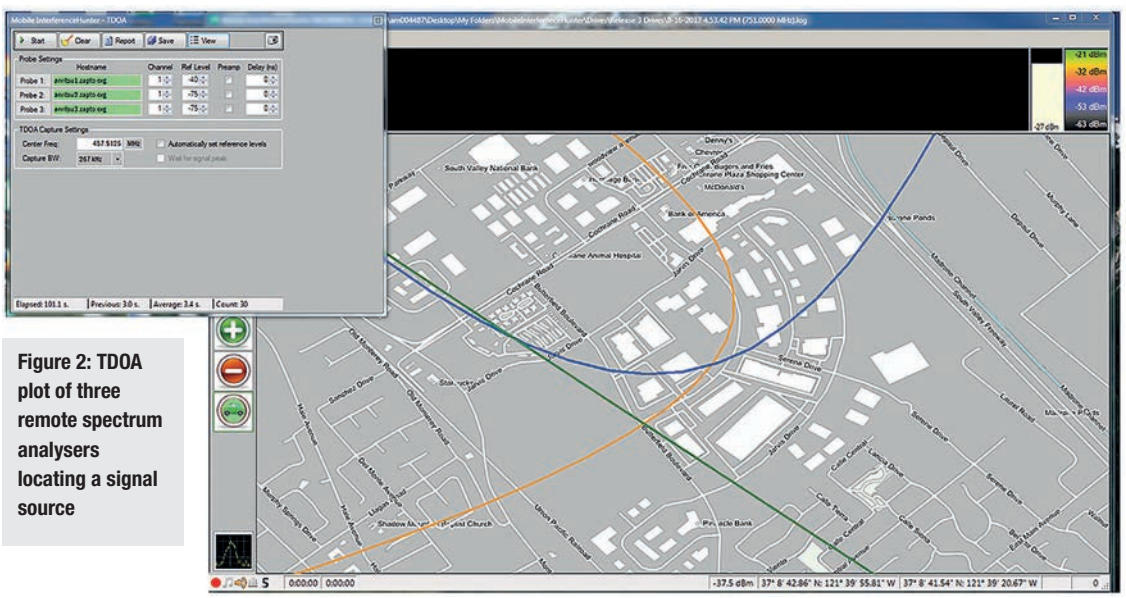


Figure 2: TDOA plot of three remote spectrum analysers locating a signal source

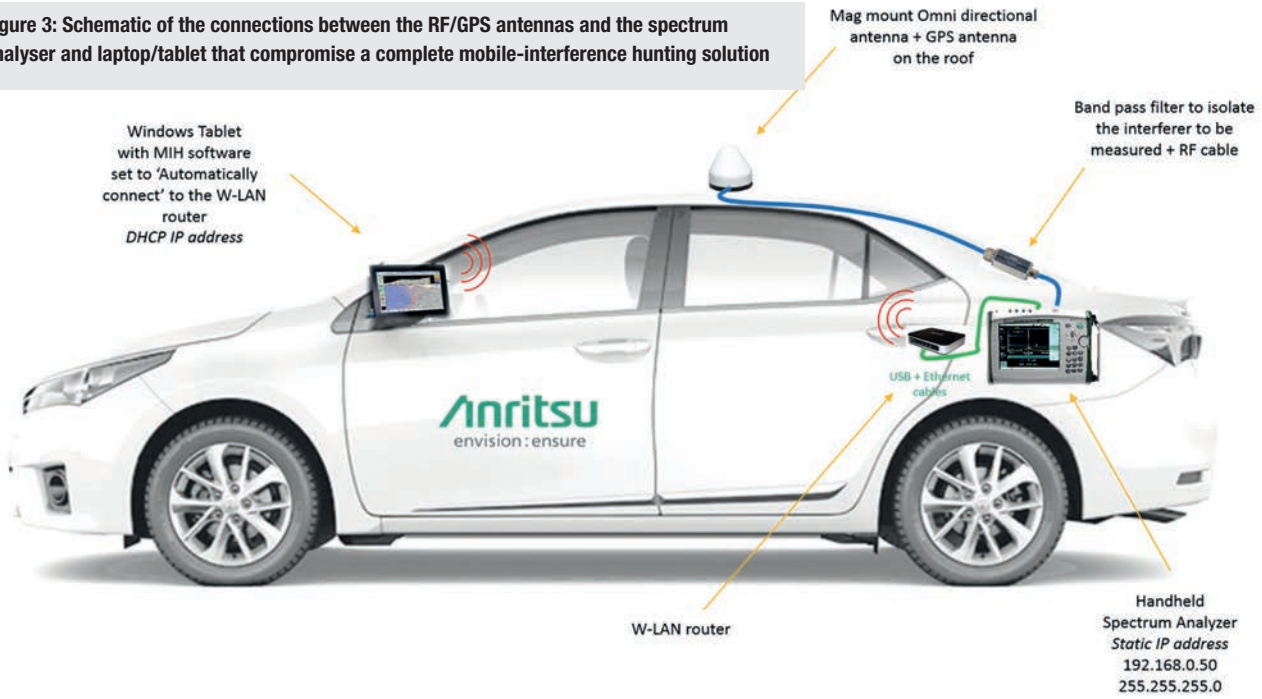
The biggest benefit of such a tool is the large amounts of data it can collect whilst driving, rather than using triangulation to pinpoint the interfering frequency from different locations with a Yagi or log-periodic directional antenna connected to the spectrum analyser. The information obtained whilst driving about will provide a better understanding of the interference's RF coverage to speed up its location identification. First, the user prepares a map of the geographical area affected by the interference, readily downloaded from any website and then installed on the Mobile Interference Hunter software, which "visualises" a route. Once the map has been prepared, the spectrum analyser becomes the key measurement tool; it connects via USB, Ethernet or Wi-Fi to a laptop or tablet.

A key aspect here, however, is to use a suitable omnidirectional antenna on the roof of the vehicle – this can be any off-the-shelf omnidirectional antenna in the frequency range of interest.

Helpful tools such as multiple static probes can be used in the field to survey the same frequency band. These devices can accurately locate a signal source using the TDOA (Time Difference of Arrival) triangulation technique, with three time-synchronised probes (Figure 2) and then feed the results to the Mobile Interference Hunter to speed up the location process in the field.

The final part of this stage in the process is pedestrian triangulation. This involves a map being prepared and downloaded to a laptop connected to the Internet via mapping software like easyMap Tools, which is later used in the spectrum analyser to pinpoint the location.

Figure 3: Schematic of the connections between the RF/GPS antennas and the spectrum analyser and laptop/tablet that compromise a complete mobile-interference hunting solution



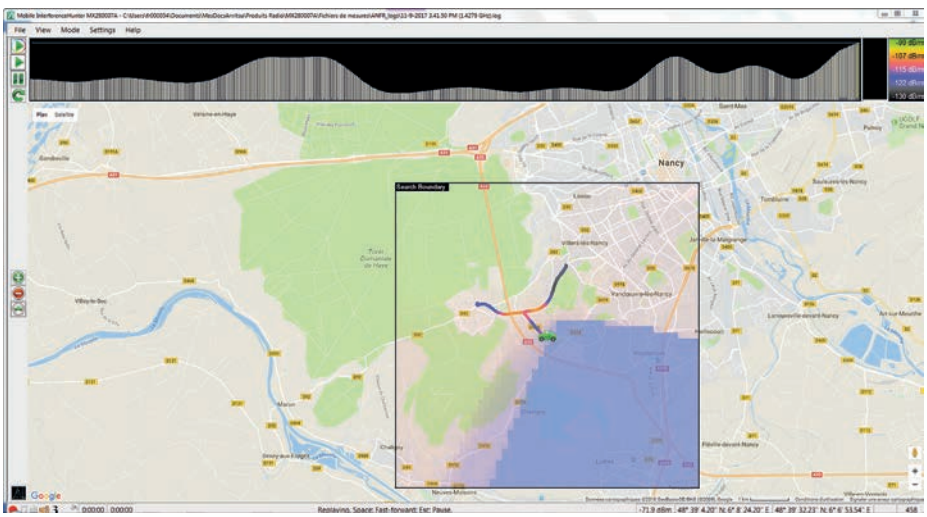


Figure 4a: Scan mode shows the direction of the drive to make more data acquisitions

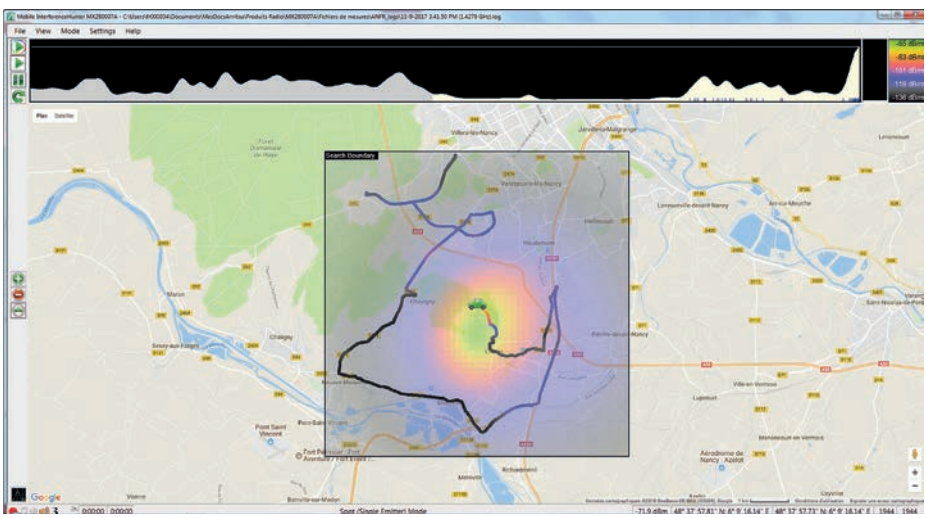


Figure 4b: Spot mode's heat map, indicating the location of the interfering signal's

Efficient location

Once these preparations are complete, it is time to locate the interfering source in the field. The handheld spectrum analyser connects to the PC/tablet via a Wi-Fi mini-router or an Ethernet cable. The RF port of the spectrum analyser is connected to the omnidirectional roof antenna, and its GPS receiver port to the GPS antenna on the roof; see Figure 3.

Depending on the environment to be surveyed, the user will set the software to suburban, rural or dense, permitting the sensitivity algorithm to consider the signal's multipath characteristics, which could be afffected by buildings and trees.

The Mobile Interference Hunter software instructs the driver where to go, with voice prompts or on the display. In the scan drive mode, the software defines the interfering signal's measured amplitude; see the blue zone in Figure 4a. In spot-drive mode (Figure 4b), the software highlights a "heat map"; the lighter the area on the heat map, the closer to the interferer.

At this stage it is important to bear in mind that all measurements are taken from ground level, so the investigator should always look around as well as up, to check whether the interference source might be on top of a building, mast or hill.

Pinpointing interferer location

Inevitably there will be situations when the mobile interference-hunting system can't exactly determine the interferer's location, such as in areas inaccessible to vehicles. In those cases, the user should apply a complementary measurement technique called direction-finding, in which the spectrum analyser is linked to a handheld directional antenna (Figure 5) and some ancillary items. Anritsu's MA2700A Handheld Interference Hunter, for example, contains a GPS receiver, an electronic compass, a preamplifier and a trigger for saving vectors. The user then walks around the estimated location of the source and uses the triangulation method to locate the exact position; see Figure 6.

Figure 5: Directional antenna attached to the handle of the Interference Hunter allowing the source of a signal to be located

Experience and patience

Troubleshooting and locating interference signals is not a trivial process; it requires patience and experience. The RF engineers in charge of this task should follow a strict protocol to locate an interfering signal source. Depending on the complexity of the signal type and its occurrence, this may take days, even weeks. Having the right set of tools can drastically reduce the time and effort it takes to find and eliminate interference. However, there are situations where the experience of the RF engineer cannot be replaced when it comes to exactly identifying and locating the source of all the troubles on a network. EW

Figure 6: Interference mapping option of the MS2720T spectrum analyser showing three different azimuths intersecting at the suspected position of the interferer