IDA 2 reveals interference – even with complex signal structures

Modern wireless services use more and more sophisticated methods of getting the broadest possible bandwidth out of the limited spectrum available. Many services are very closely spaced or even share the same frequency band. When close to a transmitting station, an incorrectly fitted GSM repeater or even just a rusty bolt (passive intermodulation) can be enough to produce noticeable interference with complex signal structures. Modern analysis methods make it possible to track down such interference.

Nowadays, conventional spectrum analyzers that use the superheterodyne principle are often no longer adequate for reliable investigation of wireless signals. Modern spectrum analyzers using digital signal processing and wideband FFTs are, though, able to distinguish very closely spaced signals and can even reliably detect overlapping signals. A key factor in this is the optimization of the relationship between the time and frequency resolutions. This optimization is in fact not arbitrary. It is referred to academically as “Küpfmüller’s uncertainty principle” or the “communications uncertainty principle”. Nevertheless, wireless signals with time resolutions in the microsecond range and frequency resolutions of a few Hertz can be measured simultaneously by using the FFT overlap algorithm of the IDA 2. Additionally, the IDA 2 is portable and therefore predestined for mobile, on-site applications. It is therefore the ideal tool for government authorities and the police as well as for intelligence services, military facilities and mobile wireless providers for monitoring complex interference in the LTE network and for rapidly identifying and localizing any such interference.

In the following, this Technical Note looks at the practical side of high-resolution analysis of wireless signals using the IDA 2. In particular, this is intended to highlight the differences between the normal spectrogram mode, which many comparable instruments can also handle well, and the High Resolution Spectrogram mode unique to the IDA 2.

Practical test: Mission possible

Narda put the analytical performance and portability of the Interference and Direction Analyzer IDA 2 to the test in cooperation with a telecommunications group. The aim of this field test was to prove the effectiveness and handling of the built in I/Q Analyzer special measurement method.

Interference A: Sporadic interference
An unwanted interference signal became apparent in the LTE uplink band within a short time (figure 1), which looked very much like a typical wideband interferer on the monitor of a conventional analyzer.

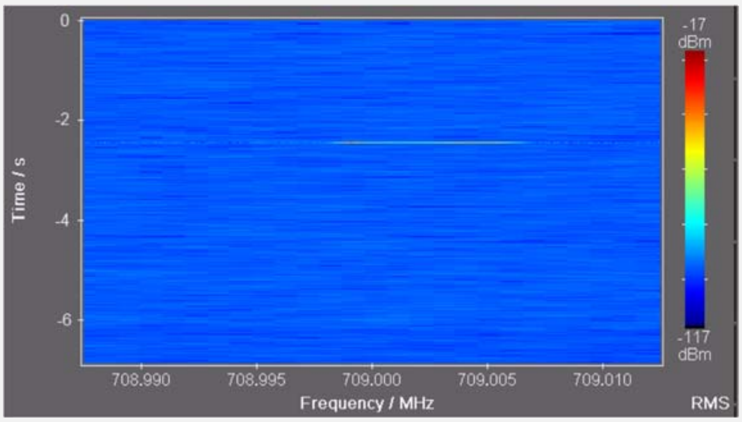

Figure 1: Typical display in normal Spectrogram mode

However, the newly developed display on the IDA 2 showed a more sophisticated picture (figure 2). With a resolution approximately one thousand times higher, the High Resolution Spectrogram enabled visualization of the onset and dying down of what was more like a narrow bandwidth signal that jumped to and fro within the band.

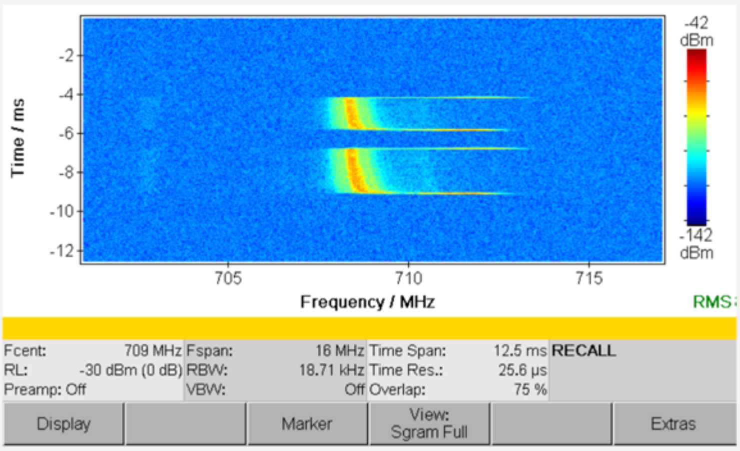

Figure 2: Signal onset and dying down made clear by the High Resolution Spectrogram of the IDA2

This fact meant that wideband interferers such as switched machinery or welding equipment could be excluded from being the cause.

SmartDF radio direction finding with GPS and a directional antenna revealed an industrial area as the transmitting zone (figure 3 reconstructed map view).

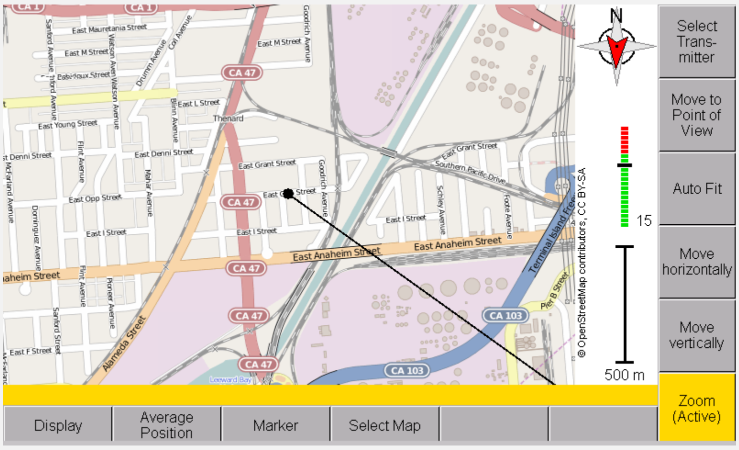

Figure 3: Optional map function (example view)

The strongest amplitude was measured in close proximity to a transmitter attached to a water tank, which was thought to be the source of the interference.

Interference B: Systematic interference

The spectrum and spectrogram for the measurement shown in figure 4 indicate a frequency-agile narrow band transmitter.

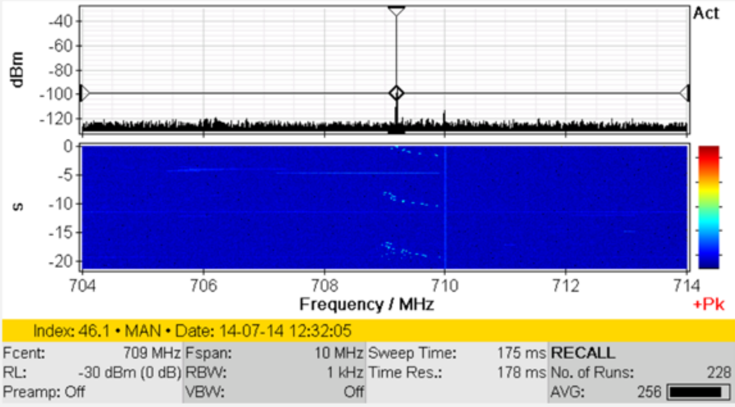

Figure 4: Frequency-agile interference signal between 708 MHz and 710 MHz

However, the time continuous High Resolution Spectrogram (figure 5) reveals that the signal is a continuous wave with a center frequency that oscillates slowly. This effect is well known, particularly with bag sealing equipment.

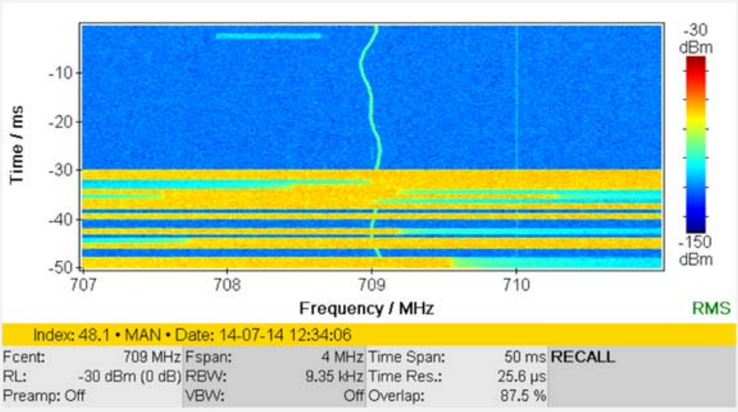

Figure 5: Time-continuous High Resolution Spectrogram uncovers the emissions from a bag sealer between the LTE payload signals

Figure 6 shows that the signal is clearly seen even with full LTE traffic present, thanks to the fine time resolution of the HighRes Spectrogram, which makes further identification easier.

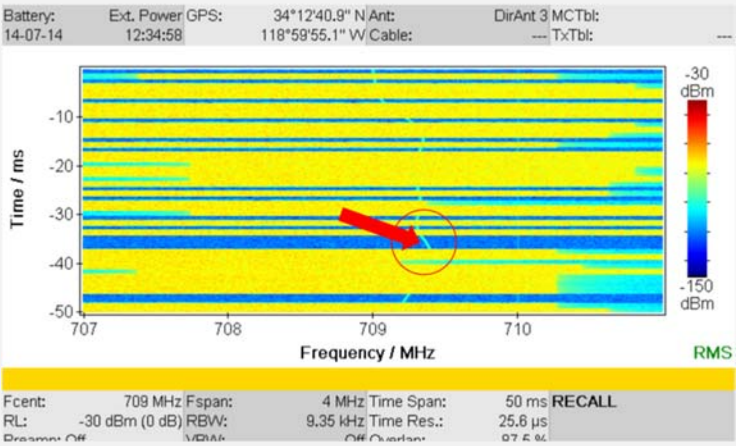

Figure 6: Signal clearly identifiable even with full LTE traffic

The product: Tracing back interference to its source

Narda Safety Test Solutions, with its headquarters in Germany close to Stuttgart, has developed a solution for tracing signals back to the interference source. The market leader in safety measuring equipment aims to reliably track down interferers and hidden transmitters with its IDA 2 Analyzer. This portable device, which weighs only 3 kg including rechargeable battery (figure 7), is a compact powerhouse with performance comparable to a laboratory instrument weighing some 20 kg.

Figure 7: Handy and compact

Analysis of agile signals is made possible through the optional I/Q Analyzer function, which gaplessly captures up to 250,000 I/Q data pairs and computes various displays from this data, such as I/Q, Magnitude (signal power vs. time), High Resolution Spectrogram (gapless time resolution down to 1 µs) and Persistence.

The technical possibilities extend far beyond those of conventional spectrum analysis: Each data snapshot records the I/Q data with a channel bandwidth of up to 32 MHz and saves the data pairs with no loss of data. Based on the same data, it is also possible to switch at will between the time and frequency domains. Sporadic interference can also be reliably identified and analyzed thanks to the trigger function as well as the digital persistence feature.

The IDA 2 captures persistence spectrums with a useable bandwidth of up to 22 MHz and a resolution bandwidth (RBW) of down to 0.1 Hz. The time resolution can be as fine as 1 µs, and level characteristics are shown with a resolution of down to 32 ns. For localization, the instrument has built in GPS along with an antenna handle with electronic compass and a switchable preamplifier as well as a matching set of antennas that covers the entire frequency range of the device.

Combined together, all the device functions enable reliable identification, analysis and localization of signals, including those signal structures that would remain undetected in a conventional spectrum display. IDA 2 is the first hand held device that retains all the recorded data in uncompressed form in the background and that can display this with the original resolution as a zoom view, where each line of pixels corresponds to a spectrum.

Summary: Nothing stays hidden!

As the field trial clearly demonstrated, the portable IDA 2 measuring instrument with intelligent RF analysis can clearly visualize interference even in the presence of superimposed signals, so that this can be made clearly identifiable.

The device measures electromagnetic signals using cutting-edge RF analysis technology, and then determines the geographical position of each interference source based on bearings previously taken using the Manual Bearing or Horizontal Scan functions. Users can display the location on a map using the optional Map function (figure 3).

Despite the complex technology behind it, the measurement procedure is uncomplicated and is easy to learn, even for inexperienced users. Once the type, cause and origin of interference, faults, or loss of power are known, it is usually possible to quickly introduce appropriate countermeasures, which is very important where applications involve a high safety risk.

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