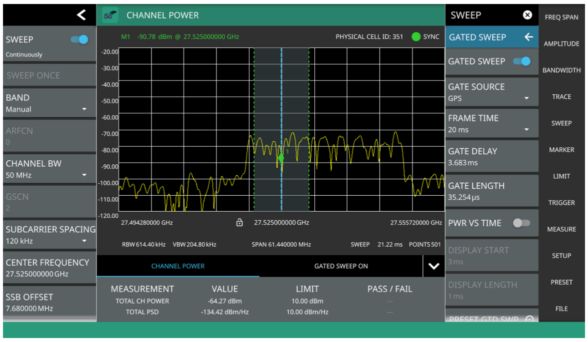
Application Note

Practical Uses for a Real-Time Spectrum Analyzer in 5G, LTE, and Wi-Fi Spectrum Monitoring

The measurement fundamental to all spectrum analyzers is their ability to measure power inside a given bandwidth at a particular frequency and to display those measurements across a frequency span. Over time, various features beyond simple power measurements were added to provide additional visibility into signal behavior. Features such as max/min hold traces, different types of power detectors (peak and negative peak), and increased sweep speeds expanded the spectrum analyzers' capabilities and utility.

Despite all the modern features and advances, the conventional spectrum analyzer has limitations when used to display certain types of signals or attempting to capture signal anomalies. Those limitations are found in two key areas: signal power density and visualization of fast digital signals. This is where the strength of a real-time spectrum analyzer (RTSA) becomes apparent.

Figure 1 highlights the difference between a conventional spectrum analyzer trace and an RTSA spectrum used to view a 5G NR downlink at 28 GHz. By default, the RTSA captures the full spectrum occupancy of the signal, whereas the conventional, swept-tuned analyzer needs to use a gated sweep to capture the time varying signal.



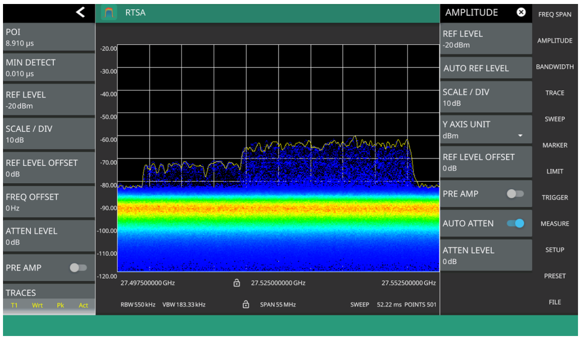


Figure 1. A conventional spectrum analyzer display of a 28 GHz 5G NR downlink (left) and the same signal displayed on an RTSA (right).

Density Display (Finding Signals Within Signals)

Where a conventional spectrum analyzer displays a power level in a particular bandwidth, an RTSA displays an image of signal intensity at each frequency and power level. Intensity is represented by a color gradient such that the color defines the relative occurrence of the signal event (i.e., as the color changes from red to dark blue, the presence of the signal decreases). Examining the 5G NR signal from Figure 2 shows how useful the RTSA is at identifying 5G NR signal characteristics not easily seen with a conventional spectrum analyzer.

Performing signal analysis of a 5G NR signal often requires the frequency or channel location of the synchronization signal block (SSB). Locating the position of the SSB within the broader carrier is difficult when they are transmitting user data at the same time as the SSB — the power present across the carrier masks the small portion of time the SSB is being transmitted. Because the power levels within the SSB are slightly different than the user data, an RTSA is able to categorize those differences via changes in color, making it very apparent where the SSB is located.

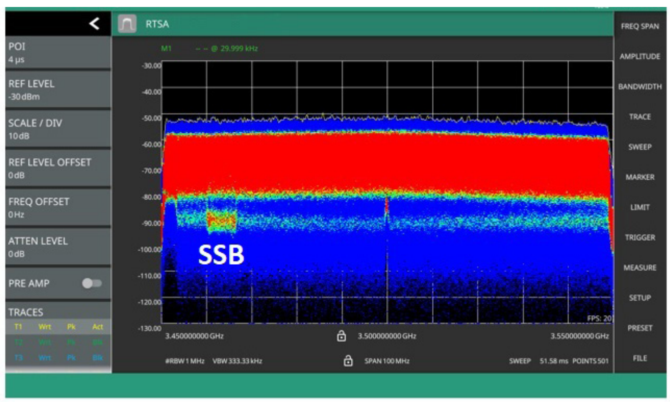


Figure 2. 5G NR signal

Detecting interference within a more powerful signal is another very useful feature of an RTSA's ability to display power density. It is common for interference to disrupt mobile phone communications, but nearly all interference hunting efforts are performed on the uplink (mobile to network). This is partially due to the difficulty of locating interference inside a strong downlink (network to mobile) signal. Figure 3 illustrates a signal found inside a much stronger LTE downlink carrier.

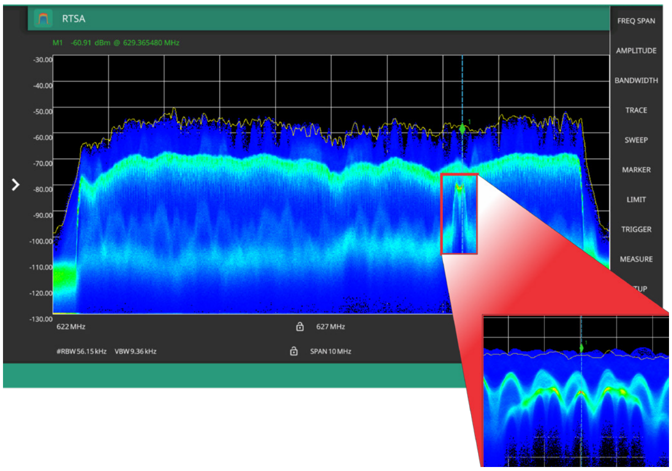


Figure 3. Intefering signal in an LTE downlink

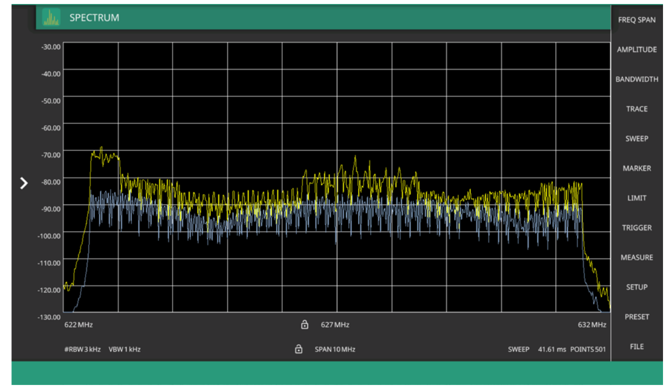


Figure 4. Conventional spectrum display

Although the downlink signal is always present, the differences between the LTE downlink and the interference can easily be seen based on the density display color differences at various frequency and power levels. This type of interference, especially if highly intermittent, is very difficult to detect with a conventional spectrum analyzer. Compare Figure 3 to a conventional spectrum view of the same signal in Figure 4 to fully appreciate the difference. The conventional spectrum analyzer view is based largely on absolute power measurements within a bandwidth and does not display the time varying nature of power within that bandwidth. Signal anomalies, such as an underlying interferer, make minor contributions to the total power and are hardly noticeable.

Persistence

Persistence adds to the dimension offered by color (density) with a degree of opacity of a color from 100% opaque to 100% translucent. With persistence, past spectrum captures (faded) are still visible when the most recent spectrum capture is displayed at full intensity (see Figure 5).

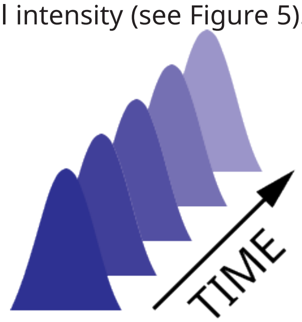


Figure 5. Persistence fading

It is much easier to evaluate bands that contain a variety of signals, especially when those signals burst on and disappear quickly. One such example is the crowded 2.4 GHz Wi-Fi band. Obtaining an accurate picture of transmissions in a busy Wi-Fi band is nearly impossible with a conventional spectrum analyzer.

In Figure 6, each individual capture is of the 2.412 GHz Wi-Fi channel (Ch. 1). The RF environment showed a variety of different transmissions from 2 different access points and various Bluetooth devices. These transmissions are difficult and time consuming to capture since the bursts appear and disappear quickly.

Contrast Figure 6 to Figure 7. Setting persistence allowed the capture of all 4 different bursts types simultaneously.

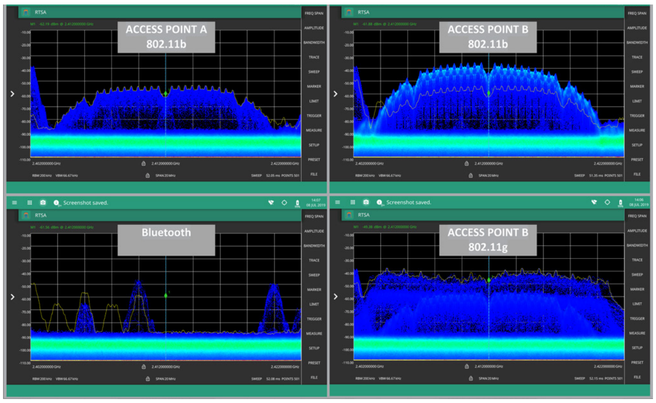


Figure 6. Wi-Fi 2.4 GHz spectrum

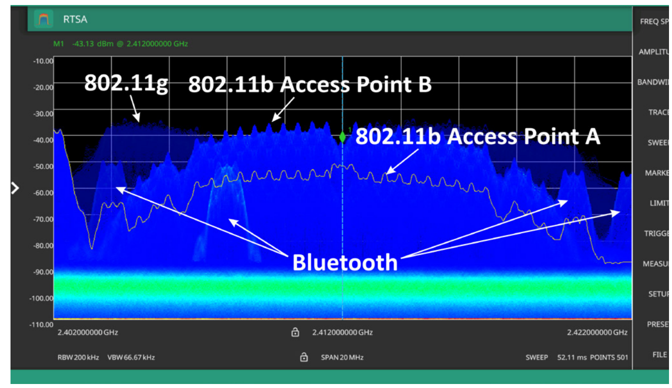


Figure 7. Wi-Fi spectrum with persistence

The amount of persistence (duration) is user configurable, providing flexibility for a variety of signal types and environments.

Conclusion

Conventional spectrum analyzers have been, and will continue to be, a workhorse tool for general RF measurements and spectral power. For fast changing signals, complex modulations, and the highly variable RF transmissions of the future, the new standard in spectrum measurement is the real-time spectrum analyzer. The Anritsu Field Master Pro^{TM} MS2090A solution is the highest performance portable RTSA available.

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