Real-Time Signal Analysis Techniques in Wireless Measurements: Two Important Capabilities

A real-time spectrum analyzer (RTSA) can find elusive signals and trigger on multiple elements of signal behavior, making it a powerful tool for solving known problems, discovering unknown problems, and optimizing RF designs. (Real-time analysis is defined here as measurements in which all signal samples are processed.) Two key RTSA capabilities are (1) comprehensive spectrum displays such as density and spectrogram and (2) frequency-mask triggering using spectral results.

Visualizing agile signals and complex signal environments

As signals become more agile and signal environments become more complex, it’s increasingly useful to represent a large amount of measurement data on a single screen (Figure 1). These new displays take advantage of the high-speed digital signal processing in RTSAs that generate thousands of spectra every second—many more than can be discerned individually by the human eye. In such cases, the most informative displays are created by compiling statistics and displaying how often a particular measurement value occurs (e.g., a specific amplitude at a specific frequency). The histogram in Figure 1 is a spectrum measurement enhanced to show frequency of occurrence. More than just a visual tool, frequency of occurrence is quantified (typically in percent) and can be read at any frequency/amplitude point with a marker. The displays are coded using color or trace intensity, and a persistence function can be added to focus attention on more recent events as older data fades away. This lets you see and focus on infrequent events or transients and separate them from other behaviors. By changing persistence and color-weighting values or schemes you can highlight specific behaviors to quickly and comprehensively assess the spectral occupancy of a frequency band.

Density or histogram displays are also excellent ways to spot rare or unexpected signals or behaviors. For situations in which timing is important, the frequency (color) coding of the density display can be traded for the time coding (Y-axis) of a spectrogram display. In an RTSA, the spectrogram display is composed of vertically stacked traces, each of which is a line representing one spectrum display update. Signal power versus frequency for each trace or spectrum display update line is encoded or mapped to color, clearly showing signal power spectrum versus time (Figure 2). Another essential use for the high speed gap-free spectrum results from RTSA processing is a spectrum-based or frequency-mask trigger. At a rate of nearly 300,000/second in an PXA or MXA analyzer with RTSA capability, calculated spectrum results are compared to upper, lower or upper/lower limit masks, with the result triggering a measurement display. Spectrum testing is also subject to logical conditions such as a requirement that the signal leaves and then re-enters the mask to generate a trigger.

One straightforward use for a frequency-mask trigger is to focus
measurements on specific signals within a spectral environment. In contrast, RF magnitude trigging can be used in many cases to measure pulsed or bursted signals; however, the magnitude technique is responsive to only total RF measured power rather than individual signals. If the desired trigger signal is not the largest one present or is not related in time to the largest signal (allowing a time delay to be used with a magnitude trigger), a magnitude trigger may not work. In Figure 3, a Bluetooth burst at a specific frequency is isolated and measured in an environment of wider and larger wireless LAN signals.

The frequency-mask trigger is especially useful in a crowded and dynamic spectrum environment. The technique is also well-suited to situations in which a signal or signal behavior in question is very infrequent and unpredictable. In such cases, it may be impractical to use techniques such as time capture and post-processing because of the improbability of capturing the desired signal in a particular capture and the time needed to review large amounts of capture data.

The frequency-mask trigger function takes advantage of the processing power of the RTSA to watch for specific signal or spectrum characteristics and can evaluate a signal for minutes, hours, or longer, as needed. In wireless applications, this capability can help detect issues such as transient interference, synthesizer stability or locking problems, frequency switching errors, and amplitude instability. For example, a frequency-mask trigger could be easily configured to detect microphonics in a transmitter or receiver or their components and subsystems.

Keysight 89600 VSA software can also take advantage of an RTSA’s frequency-mask trigger function to initiate any type of single-acquisition measurement or time-capture operation. The frequency-mask trigger can be configured from the VSA software, including pre- and post-trigger delays. With a pre-trigger delay, data and measurements are available for user-selected time before the trigger event. This is useful in wireless applications as a way to understand the causes of signal or system problems and anomalous behavior.

For more on real-time spectrum analysis capabilities, refer to the Keysight application notes Real-Time Analysis Techniques for Making Wireless Measurements and Measuring Agile Signals and Dynamic Signal Environments, free for download at www.Keysight.com/find/real-time4wireless.
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