RF Instrument Synchronization Challenges and Solutions

Submitted by Keysight Technologies

Wireless communication systems and aerospace & defense technologies use multi-antenna techniques including MIMO (Multiple Input, Multiple Output), beamforming and phased array radar. These techniques help to achieve higher data rates with improved spectral efficiency, signal quality and cell coverage by using multiple channels. A great deal of engineering and design work is required to ensure the final solution provides synchronization between the channels.

This article describes the challenges and solutions of RF multi-instrument synchronization.
The number of antennas used in wireless communications continues to grow to address the ever-increasing demands for higher data rates. Multi-antenna systems increase in complexity as antennas are added and new test strategies are required to fully test the evolving designs. The IEEE WLAN 802.11ax wireless technology is a good example, now requiring up to 8x8 MIMO configurations.

A high-priority, during development of these new systems, is to ensure the synchronization between channels as signals are generated and analyzed. Instrumentation features such as the sampling clock and event triggers play a key role in achieving instrument synchronization. A sample clock, is used to provide a common reference frequency for signal generating or analyzing instruments, such as arbitrary waveform generators or waveform analyzers, and ensure the sample clock of each instrument is aligned, resulting in aligned generation/analysis of signals. When instrument triggers are used to achieve precise time alignment between channels, engineers must consider the effects of other components in the system including cabling and external devices. Instrument's fine channel skew is used in addition to triggers to ensure the signals are transmitted and received at the same time.

As the number of channels in wireless systems continues to grow, it becomes more difficult to manage the increasing number of instruments, their interactions, and effects of more cabling, and still achieve synchronized channels. Engineers have invested and increased number of hours and costs into expanding their current test system. A better alternative is to consider a modular test system design, to increase the number of channels in a smaller, more efficient form factor. Modular instruments, such as PXI, provide test system advantages that make multi-channel synchronization easier and more robust. One key advantage is, the shared clocks and trigger signals between instruments/modules by way of the PXI chassis backplane. The PXI backplane reduces the need for cables between instruments, cable compensation, and mounting and configuring multiple instruments. Engineers can save both time and cost while improving overall multi-channel test design for greater accuracy and repeatable results.

You can learn more about PXI instruments in Multi-Channel Synchronization for MIMO and Beamforming Test