Keep Up With Testing for Today's Fastest Data Transmission Technologies

Submitted by Keysight Technologies

Data transmission in devices, interfaces and networks are becoming faster and more complex as billions of devices join internet connections for data mining and remote control. New technologies such as coherent optical transmissions and PAM-4 Ethernet are providing paths to a future with even faster data transmissions. In addition to the benefits of fast data transmission, comes the challenge for design and test engineers who must ensure data connections are fast, accurate and robust against signal distortions and link impairments.

This article describes the advantages of emerging data transmission technologies and the use of arbitrary waveform generation to achieve versatile signal creation for digital applications in optical and electrical communications.

Coherent optical transmissions

A coherent optical transmission system uses an optical receiver to extract phase, amplitude and frequency information carried by a transmitted signal. Coherent detection is well known in wireless communication systems and many optical networks are already becoming coherent centric. Coherent detection offers several key advantages for high-speed systems:

- High receiver sensitivity
- Amplitude, frequency and phase information can be extracted from an optical carrier enabling a much higher data capacity at the same bandwidth
- A DSP can be used to compensate for large chromatic and polarization mode dispersion due to optical fibers which eliminates the need for optical dispersion compensators and optical amplifiers
- Improved signal-to-noise ratio (SNR) due to the use of balanced detectors with a high common mode noise rejection ration (CMRR). Agile wavelength selection can also be achieved by local oscillator tuning without using an optical filter or demultiplexer.

Multi-level signals (PAM4)

Typical PAM-4 Ethernet communications system configurations can be components, modules or networks. PAM-4 (Pulse-Amplitude-Modulated 4-level) has several advantages over the current NRZ (Non-Return-to-Zero) Ethernet technology:

- For each level (“symbol”) PAM-4 has 2 bits of information providing twice as much throughput for the same Baud rate (28 GBaud PAM-4 = 56 Gb/s)
- From a frequency domain perspective, PAM-4 requires half the bandwidth of that of NRZ.
- Unlike NRZ, where the decision level is fixed to 0 V for a differential signal, the three slicer levels used by a PAM-4 receiver can be adaptive, or time varying.

As engineers develop new devices, interfaces and networks that support advanced data transmission technologies such as coherent optical transmissions and PAM-4 Ethernet, a method to create modulation schemes to test the devices under real world scenarios is required. Complex signal generation must include clean modulated signals, and distorted test signals at higher data rates. Arbitrary waveform generators (AWG) are known for their versatile signal creating ability including specialized data transmissions, time-domain pulse shaping with data rates up to more than 60 GBaud. Simulation of real world scenarios is made possible by adding various impairments, such as variable transition times, jitter, noise, and duty cycle distortion (DCD) to the signals. AWGs offer a unique functionality that helps engineers create signals that are reliable and repeatable so they can make measurements while working with binary and multilevel digital interfaced and coherent optical and wideband communication applications.

To learn more, see the "Getting up to Speed for Next Generation Data Transmission" M8196A Arbitrary Waveform Generator application note. (http://literature.cdn.keysight.com/litweb/pdf/5992-1174EN.pdf)