One of the key developments expected in protection systems to address the growing challenges of evolving power system is the implementation of ultra-high-speed protection and fault location based on Traveling Waves (TW). This approach operates in the time domain and enables protection relays to detect and isolate faults with trip times below 1 millisecond, significantly faster than traditional phasor-based impedance protection, which often exceeds 8 milliseconds. The increased speed enhances system stability, minimizes equipment damage, improves power quality, and contributes to overall safety.

Traveling waves are generated by sudden voltage changes, such as during a fault, and propagate at speeds close to that of light. By accurately measuring the difference in arrival times of these waves at line terminals, the fault location can be located with high precision.

This technology shift is also driving innovation in test methodologies. Due to the high-frequency content of TW signals, traditional test sets are no longer sufficient. Instead, specialized test systems capable of reproducing signals in the MHz range at secondary levels are necessary.

The test system must be a combination of software and hardware, designed to reproduce very high frequency waveforms, along with the fundamental frequency, at secondary levels. This approach allows the reproduction of all reflections of traveling waves, with their different magnitudes and distortions. Furthermore, the system makes it possible to evaluate the sensitivity of algorithms based on TW and carry out closed-loop tests. Figure 1 illustrates this test system.

Figure 1 - TW Test System