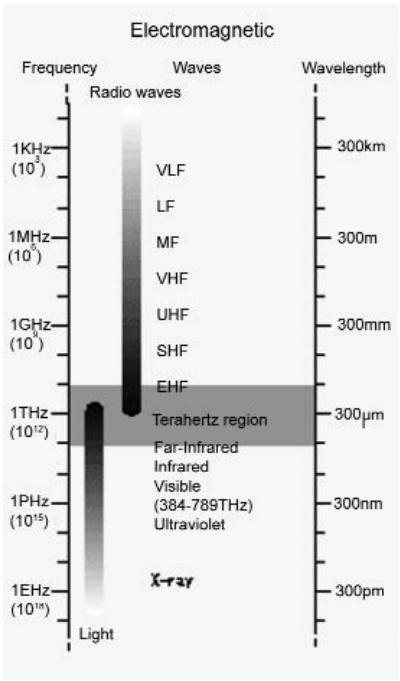
Is Terahertz Technology Ready for T&E Applications?

By G. Derrick Hinton

Future weapons and mission scenarios are driving the need for ever-increasing quantities of accurate and timely information. Today, a combination of radio frequency (RF) and wire/fiber networks is meeting these high-bandwidth requirements. RF spectrum is limited, and worldwide access to RF networks is problematic, with limited choice of available frequency. In this environment, where requirements are increasing and available spectrum is decreasing, there is a push to find methods of accessing greater bandwidths for communications and radio determination applications. This is especially true for the communications of telemetry data to meet Major Range and Test Facility Base test requirements.



This situation has prompted a desire to move to higher frequencies, where large bandwidths are more obtainable. Above 50 GHz, frequency allocations of 100 MHz or more are the rule, and allocations of multiple GHz are not uncommon. Furthermore, the demands for spectrum above 60 GHz, and up to the Terahertz range (100 GHz and above), have historically been much less than the demands for spectrum below several GHz. For these reasons, Terahertz frequencies appear to be attractive for test and evaluation (T&E) applications.

However, there are a number of significant obstacles in implementing Terahertz systems. First, the wavelength of a Terahertz signal is approximately 0.01 inches. This short wavelength has a number of implications, not the least of which is in the area of propagation. Signals of this wavelength will not bend significantly. Consequently, testers recognize that, at these frequencies, they need a clear line of sight for proper operation. The transmitter must literally be able to see the receiver. Furthermore, penetration losses through any obstacle will be substantial. Obstacles can include rain, clouds, mist, dust and atmospheric situations that might not disturb other, lower-frequency transmissions.

A second obstacle is in the area of antenna technology. For dish antennas, it is commonly thought that antenna size mitigates path loss as a function of frequency. However, this is only true up to a certain point. At very high frequencies, the physical characteristics of a dish antenna create large losses. Furthermore, antenna beam widths are extremely narrow, making the antenna pointing problem significant, thus requiring basic research in this area. Advanced antenna techniques are required for operations at Terahertz frequencies.

A previous "TechNotes" (*ITEA Journal*, December 2004/January 2005, page 15) discussed new technologies, such as nanotechnology, and their possible application as antennas. Sumio Iijima first discovered carbon nanotubes in Japan in 1991. These tiny molecules are made entirely of carbon and possess remarkable electrical and mechanical properties. Researchers foresee applications of the nanotube antennas in high-frequency Terahertz communications. However, a survey of current research and development (R&D) efforts in the Terahertz spectrum revealed a 10- to 15-year horizon before useful systems operating in this region of the spectrum could be available for T&E applications.

The T&E community must recognize that Terahertz technology is not as mature as technology for systems at more traditional frequencies. This has serious implications for those designing and developing signal generation, amplification, modulation and transmission line components. The challenges of implementing Terahertz systems for telemetry communications are formidable.

While technology is expected to advance in a way that makes the design of such systems more attainable, the issues related to propagation still remain. New and innovative system-level approaches to solve the propagation problem are required in order to capitalize on the large bandwidths available in the Terahertz range. Without a sizeable infusion of R&D investments, T&E systems operating at Terahertz frequencies will not be realized. ❑

***G. DERRICK HINTON** is program manager, Central Test and Evaluation Investment Program, for the Joint Investment Programs and Policy deputate under the Defense Test Resource Management Center. He is also chairman of the ITEA Technology Committee (itea@itea.org, Attn: G. Derrick Hinton, Chairman).*