Definition and Classification of Ultrawideband Signals

Frank Sabath,*[(1)] Eric L. Mokole,[(2)] and S. N. Samaddar[(3)]
(1) Federal Armed Forces Research Institute for Protective Technologies and NBC-Protection, 29623 Munster, Germany
(2) U.S. Naval Research Laboratory, Washington, DC 20375
(3) SFA, Inc., Largo, MD 20774, USA

The last fifteen years have witnessed increased interest in ultrawideband (UWB) systems, particularly in the areas of radar, communications, electromagnetic interference, and high-power directed energy. Since 1996, the significant development of UWB communications systems in the commercial sector has led to a definition of UWB by the U.S. Federal Communications Commission (FCC). In attempting to characterize UWB systems in a meaningful way, researchers in each diverse area have formulated their own preferred definitions of bandwidth and UWB technologies that reflect the specific needs and viewpoints of their respective communities. Unfortunately, these definitions are not mutually consistent, which has created discourse about establishing universal UWB definitions and standards.

From an engineering perspective, a single unifying definition of UWB may be desirable, but may not be advisable, because it may not be possible to combine the various device and signal definitions of UWB into one cohesive, consistent definition. To avoid the confusion and misunderstanding that currently exist, each definition of UWB and the corresponding signal parameters (like bandwidth) should be minimally consistent with other UWB definitions. In addition, any deviations among definitions should be driven by technical needs only, and the reasons for the differences should be explained and well documented.

Defining UWB signals and systems unambiguously requires: (1) a definition of bandwidth; and (2) a categorization scheme in terms of bandwidth. After analyzing the differences and goals of the three existing classification schemes, a broader and hopefully more unified classification scheme, that may suit the requirements of four specific communities (radar, communication, directed energy, electromagnetic interaction), is suggested for real-valued causal signals by partially merging the existing definitions and criteria. Even if this proposed merged scheme is unsuitable for all communities, it may provide a foundation for defining UWB radar.

To motivate further inter-community discussion, this talk compares the published UWB classification schemes for six definitions of bandwidth. For each bandwidth definition, the inconsistencies, advantages, and disadvantages associated with the three UWB definitions are illustrated by applying these definitions to four ideal real-valued waveforms.