Propagation Modeling and Validation in the DARPA VisiBuilding Program

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The main goal of the DARPA VisiBuilding Program is using radar sensors to map the interior layout of a building prior to an urban operation. In Phase I of this program, the VisiBuilding performers used model-based reasoning algorithms to map the layout of a test building specified by DARPA and designed by the JHU/APL team. These reasoning algorithms used synthetic radar returns to simulate the needed sensor data.
Given the size of the test building, ray-tracing-based propagation models were the only resort for tractable synthetic radar data generation. Traditional ray-tracing codes are invariably designed to handle homogeneous walls. To meet the VisiBuilding objective, the performers augmented these codes with models for the frequency-dependent reflection and transmission coefficients through typical inhomogeneous wall structures such as reinforced concrete and cinderblock walls. These additional models are necessary to capture the basic propagation mechanisms relevant to the VisiBuilding program. The Ohio State University team used a three-layer approximation to model the cinderblock and an equivalent resonant circuit model to derive and approximate reflection and transmission coefficients of a reinforced wall. These models were validated against full-wave method of moment and finite element codes.

The accuracy of the augmented ray-tracing models was then tested against full-wave finite difference time domain (FDTD) simulations performed by the JHU/APL team. These simulations were performed on a small benchmark building designed by the JHU/APL team. This paper discusses the propagation validation strategy adopted for the VisiBuilding program and presents the benchmark results for the augmented ray-tracing model used by the Ohio State University.