An implicit hybridizable discontinuous Galerkin time domain to solve the S- parameters in waveports

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It is important about energy coupling during the microwave systems. Since the waveguide is a simple and basic structure, which can be found in different microwave systems including filters, circulators, and so on. Thus, it is very meaningful to compute its transmission characteristics. Due to obvious transient and broadband characteristics in the complex electromagnetic environment, the time domain method can more quickly and intuitively reflect the actual electromagnetic phenomenon compared with frequency domain methods.

In recent years, the discontinuous Galerkin time domain (DGTD) method has been applied into different microwave systems. However, the maximal time step size is limited to by the smallest elements when the microwave systems has complex structures with some small size meshes. Besides, the DGTD method's number of globally coupled degrees of freedom (DOFs) is much greater than finite element method (FEM) for the same accuracy, which greatly reduces computational performances.

In this paper, an implicit time scheme is considered due to its unconditionally stability which means time step can be properly increased when dealing with local refined meshes. However, the implicit time scheme needs to solve a global linear system. In order to reduce the number of DOFs, an implicit hybridizable discontinuous Galerkin time domain (HDGTD) is proposed. Unlike the DGTD method can obtain the electric and magnetic fields only though elements, the HDGTD method needs to use hybrid variable to represent the numerical flux of the DGTD method, and combine with a conservativity condition to obtain a global linear system that is only related to hybrid variable. Once the hybrid variables of all face elements are solved out, the electric and magnetic fields can be obtained. The reduction in DOFs directly leads to less computational time and memory consumption. In particular, the implicit HDGTD is more effective than the DGTD method for complex structures with refined meshes. Finally, applying the proposed HDGTD method into the computation of S-parameters, the transmitted and reflected wave of waveports can be obtained easily.