This thesis is devoted to explore the potentialities of the Deformable Simplicial Complex (DSC) method for solving various problems. The DSC is an explicit interface tracking method that relies on meshes, triangle in 2D and tetrahedra in 3D, to represent piecewise constant functions. One can consider the DSC as the potential alternative for the popular level set method with additional explicit-geometric-information. In particular, the goals of this thesis include: the applications of the DSC in image segmentation, fluid simulation, and a method for DSC efficiency optimization. Image segmentation faces many difficulties in dealing with volume data sets that represent multiple materials (phases) such as CT and MRI scans. In this thesis, we propose a novel method for 2D and 3D image segmentation using the DSC. The most important advantage of the method is multi-phase support with accurately defined boundaries. Besides, this method is robust to noise because we distinguish the image space (the fixed grid) and feature space (segmentation represented by the DSC meshes). Additionally, the outputs of our method, which are meshes, are useful for simulation and analysis. Simulation of fluid is important for understanding fluid properties and visualization, but it is challenging due to a massive amount of topological changes (surface splits and merges). With the DSC, handling the topology becomes trivial. We show that the DSC can be used for multi-phase fluid tracking with complex topology. The DSC is primarily designed for memory efficiency and accuracy. In many cases, including image segmentation and fluid tracking problem, performance is highly concerning. Our last contribution is a caching scheme that stores computed mesh data for later retrievals. The proposed method helps improving the DSC performance up to five times and enabling parallel mesh processing.