In this study the particle-based Lattice Solid Model (LSM) is used to provide a framework to simulate and study the micro-dynamics of fault zones, rocks and nonlinear dynamics of earthquakes. This model consists of a lattice of interacting particles and has motivated by short range molecular dynamics concepts, particles that represent grains of rock (or building blocks of grains) and interactions which are specified accordingly. The new modular and flexible LSM approach allows different microphysics to be easily added and removed at the grain-scale and enables the nonlinear behavior of discontinuous solids such as rocks to be simulated relative simplicity. In previous works, intact material was modeled as particles bonded together by elastic-brittle links in a regular 2D triangular lattice and the model was applied to the study of fault zone evolution. The LSM has been extended to simulate different properties at the grain scale such that these properties can be switched on or off in order to consider their impact in the macroscopic behavior. One of the most advantages of this model is that improved to allow three dimensional simulations to be performed and particles of various sizes to be specified. This provides a basis to investigate nucleation, rupture and slip pulse propagation in complex fault zones without any limitation of a regular low-level surface geometry. In future works it is possible to compare the obtained results with the other models and we can prove the efficiency of this model, which is important in evaluating the reliability of LSM.