Fault Injection, Detection, and Correction in CLAMR Using F-SEFI

What is CLAMR?
CLAMR is cell-based adaptive mesh refinement (AMR) mini-app hydrodynamic simulation modeling shallow water equations. A cylindrical shock is created at the center of the mesh, and symmetry is used in the following time steps to simulate the shock moving towards and away from boundaries. The shallow equations simulate fluid flow using the conservation laws of mass, x momentum, and y momentum. Due to the incompressibility of water, the density of the water remains constant, and the height of a column of water is equal to the total mass of that column. CLAMR was developed at LANL as a test bed for hybrid algorithm development. (http://github.com/losalamos/CLAMR)

What is F-SEFI?
F-SEFI is a fine-grained software-based soft error fault injector that injects simulated faults into running scientific applications. These faults can be applied to any operation and a specific bit field within that operation. F-SEFI can target specific functions and line numbers of a target application. F-SEFI injects faults by intercepting hypcalls from the QEMU virtual machine hypervisor, and manipulating instructions before they are delivered to the host system for execution. F-SEFI was designed and developed by USRC, HPC-5, at LANL.

Visualization of Faults in CLAMR

Resilience Against Faults
Because CLAMR is an AMR application, the number of cells vary from iteration to iteration. The number of cells affected by a single fault injection was dependent on the temporal location of the fault. Faults injected early caused errors to propagate to neighboring cells.

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