Massively Parallel Simulations with DOE's ASCI Supercomputers: An Overview of the Los Alamos Crestone Project (U)

Bob Weaver
Los Alamos National Laboratory

The Crestone Project is part of the DOE ASCI Program at Los Alamos. The main goal of this project is to investigate the use of continuous adaptive mesh refinement (CAMR) techniques for application to problems of interest to the Laboratory. There are many code development efforts in the Crestone Project. In this overview I will discuss the SAGE and the RAGE codes. The SAGE (simple adaptive grid Eulerian) code is a one-, two-, and three-dimensional multimaterial Eulerian massively parallel hydrodynamics code for use in solving a variety of high-deformation flow problems. The RAGE CAMR code is built from the SAGE code by adding a two-temperature radiation diffusion solver. The goal of this massively parallel version of the codes is to run extremely large problems in a reasonable amount of calendar time. Our target is scalable performance to 10,000 processors on a 1 billion CAMR computational cell problem that requires hundreds of variables per cell, multiple physics packages (e.g. radiation and hydrodynamics), and implicit matrix solves for each cycle. The largest scale simulations we do are three-dimensional. Current ASCI platforms range from several 3-teraOPS supercomputers to one 12-teraOPS machine at Lawrence Livermore National Laboratory, the White machine. Later this year there will be a 30-teraOPS machine installed at Los Alamos. Each machine is a system comprising many component parts that must perform in unity for the successful run of these simulations. Key features of any massively parallel system include the processors, the disks, the interconnection between processors, and other fundamental units of the system. I will give an overview of the current status of the Crestone Project codes SAGE and RAGE. These codes are intended for general applications without tuning of algorithms or parameters. We have run a wide variety of physical applications from millimeter-scale laboratory laser experiments to the multikilometer-scale asteroid impacts into the Pacific Ocean. Examples of these simulations will be shown. The goal of our effort is to avoid ad hoc models and attempt to rely on first-principles physics. In addition to the large effort on developing parallel code physics packages, a substantial effort in the project is the verification and validation (V&V) of the resulting codes. Examples of this V&V for our project will be discussed.