LARGE-SCALE BLAST CALCULATIONS ON MASSIVELY PARALLEL MACHINES

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Key Words: Blast Simulation, Euler Solvers, Parallel Computing, CFD, FEM

Blast mitigation and protection analysis require large-scale, first-principles- based CFD runs to predict accurately pressure and impulse loads on structures. Over the last three decades, a number of CFD codes have been developed and validated for this class of problems. Some production runs require up to $1.5 \cdot 10^9$ elements and 10^5 timesteps. Current efforts are directed at improved physics (in particular chemical reactions), and the long-term effect of vortices inside buildings. For both of these efforts, the already considerable CPU requirements of usual production runs are only expected to increase further. Given that the clockrates of CPUs are not increasing, the only way to reduce run-times is via massive parallelism. The advent of computers with up to a million cores has opened the possibility of reducing turnaround times by two orders of magnitude. The present effort is directed to making this exciting new possibility a reality.

The figure below shows the results of a typical run (blast in city center). The mesh had approximately $1.15 \cdot 10^9$ elements. It was subdivided into 3,072 domains, which communicated via MPI. Furthermore, 16 cores per domain were used to update the flowfield. Thus, in total approximately $5.0 \cdot 10^4$ cores were used. The run required only 15 minutes of wall clocktime to complete.

Scaling to such large number of processors is not straightforward. The complete simulation pipeline (pre-processing, mesh generation, flow solver, post-processing) needs to be modified appropriately. The final paper will contain details of the changes required, implementational issues, and the runs currently being performed.