Chapter 9

GRID SUPERCOMPUTING

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ABSTRACT

We sketch a large-scale computable general equilibrium model of the macroeconomy that includes modern features such as financial derivatives. This model can be used to examine proposed new economic policies that involve large structural changes in the economy. To simulate and study the model, considerable computational power is required for extensive Monte Carlo simulations. We propose using a grid supercomputer to do these Monte Carlo simulations so that the results can be obtained in a reasonable amount of time. To evaluate the new policy, the supercomputer will run two sets of Monte Carlo simulations: (1) Baseline (2) Supercharged. Both sets contain trillions of stochastic simulations. After running both the baseline and supercharged simulations, the social welfare in the two possible scenarios can be compared to see if economic welfare was improved by the proposed supercharged economic policy.
users in 170 countries with average computing power of 1.38 PFLOPS. These compare favorably to supercomputers although grid computers cannot run LINPACK on the large problem that is the benchmark by which supercomputers are measured. The fastest supercomputer in the world is the Cray® Jaguar® at 1.759 petaflops at Oak Ridge National Laboratories Tennessee USA. The second fastest supercomputer in the world is the Dawning® TC3600 Blade® at the National Supercomputing Center in Shenzhen China (Top500.org, June 2010).

Grids link together separate computers to make a virtual super-computer. The separate computers may be widely dispersed geographically but are linked together by conventional network interfaces such as internet or ethernet. The separate computers are usually complete computers and may run different operating systems. This distinguishes grid computing from cluster computing, concurrent computing, parallel computing, distributed computing, and traditional supercomputing. These have more standardized compute nodes and often faster networks linking the nodes. Sometimes the compute nodes are specialized for particular applications and thus can be much faster than grid computers for those applications. Dedicated supercomputers may have field-programmable gate array (FPGA) chips on compute nodes that are specially designed for particular financial algorithms (Mackin, 2009) that can achieve a tenfold speed increase while cutting electrical power consumption in half (Mackin, 2008). Re-configurable computing is the use of a FPGA as a coprocessor to a more general-purpose computer (Kelley, 2011). In a similar manner grid computing can benefit from the graphics cards in many distributed complete computers which are also powerful processors. General purpose computing on graphics processing units (GP-GPU) use fact that GPUs have been heavily optimized for computer graphics processing which is dominated by the parallel operations of rendering pixels independently and extensive linear algebra manipulations.

Technologies of grid, cluster, concurrent, parallel, distributed computing overlap to some extent while undergoing rapid development. Word definitions have not become extremely precise so in this book we use the term grid computer liberally. A distributed system is any set of autonomous computers that communicate through a network in order to achieve a goal. The problem is divided into sections that can be computed by the separate machines. In parallel computing all processors have access to a shared memory that can be used to exchange information between processors, but they do not have local memory, as does the grid. For supercomputers, “Systems with global shared memory allow access to all data in the system’s memory directly and efficiently, without having to move data through I/O or networking bottlenecks. The impact can be dramatic ... the latency for messages through system I/O are 1000 to 10000 greater than communication within the memory domain” (SGI, 2010). In distributed computing, each processor has its own private memory (distributed memory). Information is exchanged by passing messages between nodes. A massively parallel processor (MPP) is a single computer with many networked processors with specialized interconnect networks. Clusters use commodity hardware for networking. MPPs tend to be larger than clusters with more than 100 processors. In MPP each CPU contains its own memory and copy of the operating system and application. In a distributed-shared-memory computer memory is physically distributed among the many processors, but can be programmed as if it were shared (UCAR, 1999).

Grid computing is the most distributed form of parallel computing. Grids are most cost effective on “embarrassingly parallel” tasks that require little communication between nodes. Grid computing harnesses the oversupply of computers to accomplish needed computing by grabbing spare cycles when computers are idling. Sometimes
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