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ESMF performance evaluation and optimization

P. Li (1), S. Cheung, G. Theurich (2), C. DeLuca (3)

(1) Jet Propulsion Laboratory, California Institute of Technology, USA, (2) Silicon Graphics Inc., USA, (3) National Center for Atmospheric Research, USA(peggy.li@jpl.nasa.gov / Phone: 001-818-3541341)

The Earth System Modeling Framework (ESMF) is a component-based software framework used for coupling complex Earth system applications, such as climate, numerical weather prediction, ocean circulation, and data assimilation. Its purpose is to increase ease of use, performance, portability, interoperability, and code reuse. The ESMF consists of two layers: a superstructure layer for coupling model components and an infrastructure layer that includes data structures and utilities for developing individual components.

We have performed a series of performance evaluation on ESMF applications at both the superstructure and infrastructure levels. In this paper, we will report the results from two performance studies: a scalability evaluation of the ESMF superstructure functions on large processor sets and a grid redistribution overhead benchmark based on two different-resolution grids used in the CCSM (Community Climate System Model).

The ESMF superstructure benchmark was conducted on the Cray XT3 at Oak Ridge National Laboratory and the SGI Altix at NASA Ames. The component overhead and the ESFM initialization/termination time were measured from 4 processors up to 2048 processors. We found that the ESMF component function overhead increases logarithmically with the number of processors used. The ESMF initialization and termination time is determined by the parallel I/O performance of the test machine.

The grid redistribution overhead benchmark measures the time to redistribute an arbitrarily distributed 2D global grid to another arbitrarily distributed grid. The grids used in the benchmark are the CCSN T42 (128x64) and T85 (256x128) grids and the grid distribution mimics the actual grid distribution used in the CCSM Atmosphere

Model (CAM) and CCSM Land Model (CLM). The performance was measured on the IBM-SP clusters and the Cray X1E. We will report the timing results for both the initialization and actual redistribution, the comparison of the IBM-SP and Cray X1E, and the optimization we implemented during the study.