Archive - Potential NGI Applications

Distributed Modeling Laboratory for Mesoscale Meteorological Studies: Sponsored by NSF

Categories

Environment, Distributed Computing

Description

This application is the construction and operation of a distributed modeling laboratory for mesoscale meteorological studies. The demonstration project envisioned aims to create a virtual machine built from the Next Generation Internet (NGI) and from high-performance computers at four atmospheric research institutions in the western U.S. The application would exploit NGI connectivity to join dispersed computing resources in the operation of numerical weather prediction models in a distributed computing mode. The resultant computing/network infrastructure, or Distributed Numerical Weather Prediction Laboratory, would be used for mesoscale modeling studies and experiments.

The project would create the laboratory by uniting computing resources at the partner institutions via the NGI, with support from the National Science Foundation. The laboratory would be used for experiments and demonstrations involving weather simulations, local data assimilation, model output distribution, and real-time forecasting and data analysis. It could also be used for instruction and graduate-level training. An initial experiment would investigate distributed numerical weather prediction through the joint operation of a mesoscale forecast model, the MM5. For this experiment, the computation would be distributed among the partner sites, with fine grids at each node running as two-way nests of a coarse grid run at NCAR. The multi-domain simulation would thus be a product of the virtual machine emerging from I2's unification of nodal computing resources. Future laboratory experiments could investigate ensemble and real-time mesoscale forecasting.

Requirements

The bandwidth required for distributed model operation has been estimated from scaling the MM5 job performance on currently-available hardware to (i) the estimated model grid sizes and physics in the initial experiment and (ii) the capabilities of

improved computational hardware which may be available. Note two things about the estimates given below. First, the fine grid simulations would be the controlling components of the computing demand and of the distributed system traffic. The throughput numbers mainly reflect the fine grid traffic. Second, the numbers reflect a scaling to a particular compute server offering good performance for the MM5.

For the MM5 configuration in the initial experiment, it is estimated that each of 4 nodes running fine grids (e.g., 1 each at UU, UA, DRI, and NCAR) would generate 12 Mbyte of data every 5.22 sec. The NCAR fine grid node, however, would not have to pass its output to the coarse grid via the NGI; such traffic would be internal. Thus, regarding the traffic from the remote fine grids, the total would be 36 Mbyte every 5.22 sec. This translates to 288 Mbit every 5.22 sec, or 55.2 Mbit/sec sustained. One currently-available network which could provide such connectivity is the vBNS, which at present offers OC-3 capacity rated at 155 Mbit/sec. In practice, however, top deliverable rates would be about 110 Mbit/sec due to datagram overhead, with operational rates of 60-80 Mbit/sec having been monitored in NCAR vBNS traffic thusfar. While the vBNS is in the process of being upgraded to OC-12 (622 Mbit/sec), nodal ties to this backbone will likely represent limiting links, and thus a national network providing for uniformly higher capacity, such as an NGI, would better support the proposed application. In addition, success in remotely-distributed modeling and numerical weather prediction on a limited scale, such as proposed here, would encourage similar efforts of larger scale and increased participation. The broadening of the concept and application proposed would demand a comprehensive, national, high-bandwidth network such as a Next Generation Internet.

Partners and Potential Partners

Initial partners:

- National Center for Atmospheric Research (Colorado)
- University of Utah
- Desert Research Institute (Nevada)
- University of Arizona

In the future, additional institutions could use or augment the laboratory.