High Performance Computing for Weather Prediction

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Abstract

Medium Range Weather Prediction has great impact on agriculture, disaster management and mitigation purposes. The domain of influence for medium range weather prediction is the whole globe because the conditions in any region, gets advected and influence conditions of the rest of the globe. The partial differential equations governing the dynamics of the atmospheric flow are non-linear in nature. Hence, they need to be solved numerically with very good accuracy. For a global weather forecast model of reasonable resolution, huge computation power is needed to provide the forecast well in time so that the forecast information could be made use of by the consumer agencies. To meet these stringent computational requirements, the prohibitively expensive vector super computers are used in most of the national centers, which provide operational weather forecasts.

Computer Division, Bhabha Atomic Research Centre, India has provided a low cost turn-key solution for the operational weather forecast based on in-house developed ANUPAM parallel processing technology, which also meets the rigors of the operational numerical weather prediction center. This solution has been providing quality forecasts at the National center for Medium Range Weather Forecasting (NCMRWF), New Delhi, India since the last FIVE years.

The Meteorological Data from various observing platforms like pilot observations, Satellite observations, balloons, ships, observatories etc from all over the globe is received at the Regional telecommunication center New Delhi. This data is transmitted at half an hour intervals to NCMRWF. These data are in different formats. These data are decoded and subjected to various quality control tests. Next, the data is analyzed using the Spectral Statistical Interpolation Scheme. The resultant data is used to generate guess files for the next assimilation cycle. Then, forecast cycles are run using T-80 Global Spectral Model (18 sigma levels). These output files are then processed to convert the sigma level spectral fields to pressure level grid point fields. Next, these files are rendered into meaningful and easy to comprehend color plots using various visualization schemes. The resulting numerically forecasted parameters are disseminated well in time to consumer agencies all over the country namely various meteorological centers, Defense, Airports and Agricultural centers etc.

Initially, a feasibility study was conducted by porting the entire weather forecast suite on sequential platform by modifying / replacing the CRAY specific code to suite the new platform. The feasibility of porting and the accuracy of results were for this sequential version was tested on various platforms like SUN, HP, I860 based

machines, ALPHA servers etc. To provide for an operational forecast center, the following issues were considered:

- Which Processing Element to be used?
- Which interconnection network to be used (ATM, ETHERNET 100/1000)?
- Its topology (Bus, Switch …)?
- Cost Effectiveness of the solution?
- Ease of unifying the various data received in different formats
- Ease of Upgradation when new processors are to be used as Processing Elements
- Utility value of the current Processing Elements when New Processing elements come in
- Redundancy to be built in for the operational setup
- Good Archival capability

In this presentation, an overview of the implementation details of building various clusters with different processing elements and interconnection networks, parallel libraries developed and issues involved in porting codes from shared memory architecture to that of distributed memory architecture will be given. This talk will describe the efforts involved in establishing an operational numerical weather prediction center based on parallel processing technique that culminated in providing a very cost-effective solution and replacing the CRAY XMP216 at the National Center for Medium Range Weather Forecasting (NCMRWF), India.