Realtime Air Diffusion Prediction System

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Abstract
We implement Realtime Air Diffusion Prediction System which is designed for air diffusion simulations with four-dimensional data assimilation. For realtime running, we parallelize the system using MPI (Message Passing Interface) on distributed-memory parallel computers and build a cluster computer which links high-performance PCs with high-speed interconnection networks. We use 16 2-CPU nodes and a Myrinet network for the cluster

Keyword: *air diffusion, parallel system, cluster*

1. Introduction
In this research, we implement Realtime Air Diffusion Prediction System which is a parallel Fortran model running on distributed-memory parallel computers. The system is designed for air diffusion simulations with four-dimensional data assimilation.

2. Realtime Air Diffusion Prediction System

2.1 Air diffusion prediction system
For regional air quality forecasting a series of dynamic downscaling technique is adopted using the NCAR/Penn. State MM5 model which is an atmospheric model. The initial data for realtime air quality forecasting has been assimilated from the synoptic meteorological observation, automatic weather station data, weather radar echo, and satellite data. This process might be essential to simulate reasonable prediction of air flow (Fig. 1).

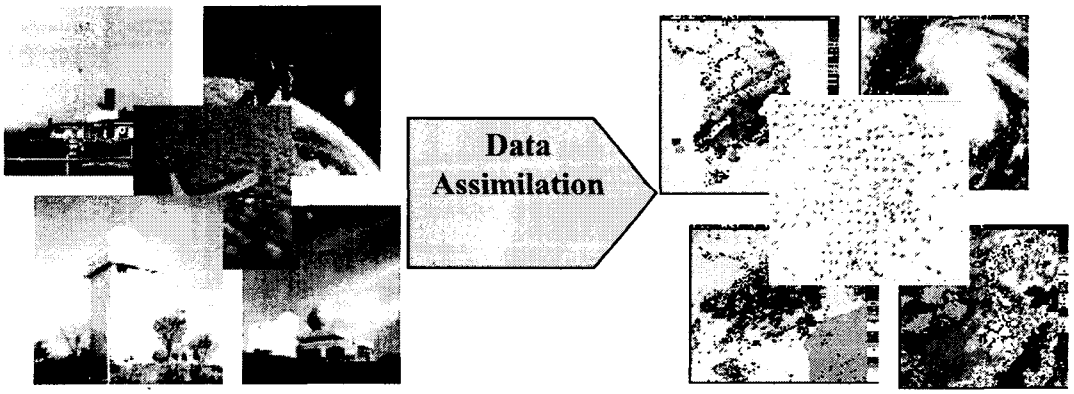

Fig. 1. Data processing for realtime air quality forecasting

2.2 Schematic structure of the system

The realtime initial data have been provided daily from the KMA (Korean Meteorological Administration) global spectral model output. It takes huge resources of computation to get 24 hour air quality forecast with this four step dynamic downscaling (27km, 9km, 3km, and 1km). Parallel implementation of the realtime system is imperative to achieve increased throughput since the realtime system have to be performed which correct timing behavior and the sequential code requires a large amount of CPU time for typical simulations.

Fig. 2 illustrates the computational processes for realtime air quality forecasting. The initial and boundary condition for MM5 are provided from observation and the KMA global spectral model. The MM5 has nested for the Asia domain. In this procedure LAPS (local analysis and prediction system) provide more realistic initial atmospheric conditions for further integration. Separately the atmospheric air pollution monitoring data has initialized, and then introduced to the coupled MM5 and air quality model. For fast integration the ENVICOM(2 CPU 16 node cluster) is used.

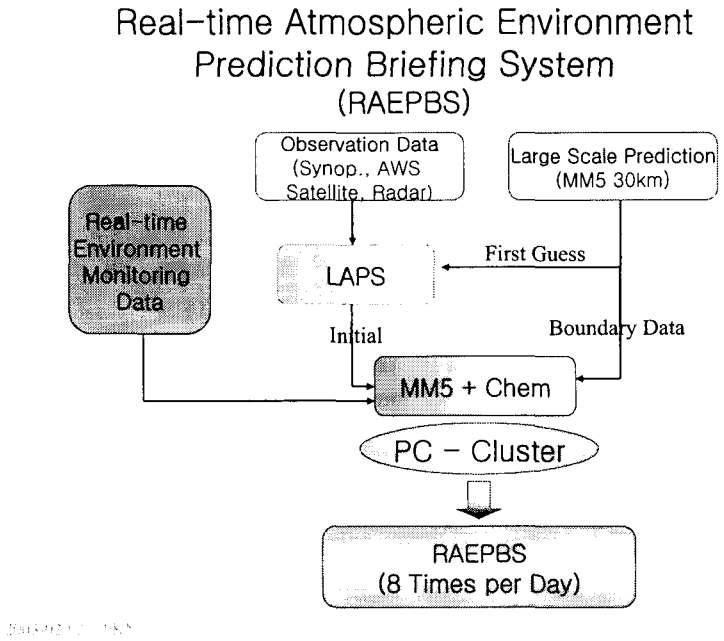

Fig. 2. Schematic diagram for integrating procedures

2.3 Parallel processing system

The parallel system uses MPI (Message Passing Interface), a standard library to support high-level routines for message passing. We validate the parallel model by comparing it with the sequential model. For realtime running, we implement a cluster computer which is a distributed-memory parallel computer that links high-performance PCs with high-speed interconnection networks. We use 16 2-CPU nodes and a Myrinet network for the cluster (Fig. 3). Since cluster computers more cost effective than conventional distributed parallel computers, we can build a dedicated realtime computer. The system also includes web based GUI (Graphic User Interface) for convenient system management and performance monitoring so that end-users can restart the system easily when the system faults. Performance of the parallel model is analyzed by comparing its execution time with the sequential model, and by calculating communication overhead and load imbalance, which are common problems in parallel processing. Performance analysis is carried out on our cluster which has 16 2-CPU nodes.

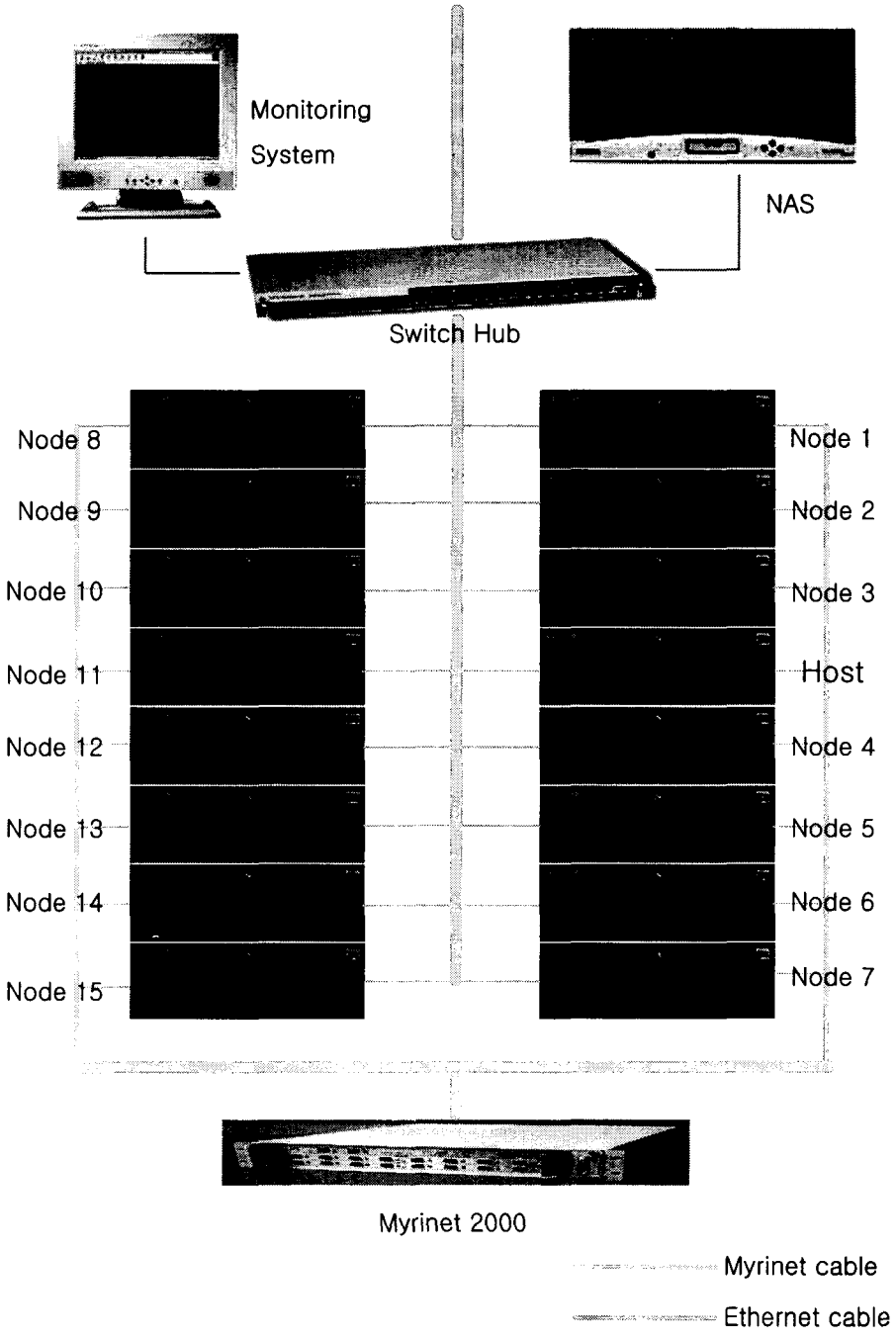

Fig. 3. PC-cluster for realtime air diffusion prediction system