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A large-scale statistical analysis system for satellite and ground-based observations via Grid Datafarm

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In the Solar-Terrestrial Physics (STP) field, the amount of satellite observation data has been increasing every year. It is necessary to solve the following three problems to achieve large-scale statistical analyses of plenty of data. (i) More CPU power and larger memory and disk size are required. However, total powers of personal computers are not enough to analyze such amount of data. Super-computers provide a high performance CPU and rich memory area, but they are usually separated from the Internet or connected only for the purpose of programming or data file transfer. (ii) Most of the observation data files are managed at distributed data sites over the Internet. Users have to know where the data files are located. (iii) Since no common data format in the STP field is available now, users have to prepare reading program for each data by themselves.

To overcome the problems (i) and (ii), we constructed a parallel and distributed data analysis environment based on the Gfarm reference implementation of the Grid Datafarm architecture. The Gfarm shares both computational resources and perform parallel distributed processing. In addition, the Gfarm provides the Gfarm filesystem which behaves as a virtual directory tree among nodes. The Gfarm environment is composed of three parts; a metadata server to manage distributed files information, filesystem nodes to provide computational resources and a client to throw a job into metadata server and manages data-processing scheduling.

In the present study, both data files and data processes are parallelized on the Gfarm with 6 file system nodes: CPU clock frequency of each node is Pentium III 1GHz, 256MB memory and 40GB disk. To evaluate performances of the present Gfarm system, we scanned plenty of data files, the size of which is about 300MB for each, in three processing methods: sequential processing in one node, sequential processing by each node and parallel processing by each node.

As a result, in comparison between the number of files and the elapsed time, parallel and distributed processing shortens the elapsed time to 1/5 than sequential processing. On the other hand, sequential processing times were shortened in another experiment, whose file size is smaller than 100KB. In this case, the elapsed time to scan one file is within one second. It implies that disk swap took place in case of parallel processing by each node. We note that the operation became unstable when the number of the files exceeded 1000.

To overcome the problem (iii), we developed an original data class. This class supports our reading of data files with various data formats since it converts them into an original data format since it defines schemata for every type of data and encapsulates the structure of data files. In addition, since this class provides a function of time re-sampling, users can easily convert multiple data (array) with different time resolution into the same time resolution array.

Finally, using the Gfarm, we achieved a high performance environment for large-scale statistical data analyses. It should be noted that the present method is effective only when one data file size is large enough. At present, we are restructuring the new Gfarm environment with 8 nodes: CPU is Athlon 64 x2 Dual Core 2GHz, 2GB memory and 1.2TB disk (using RAID0) for each node. Our original class is to be implemented on the new Gfarm environment.

In the present talk, we show the latest results with applying the present system for data analyses with huge number of satellite observation data files.