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Dynamical Evolution of the Oort Cloud formation - Visualisation

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Lot of complicated applications computed in Grid enviroment used visualization of the research final results. After the completion of each sub-simulation step all results are stored in the reserved output area of the Storrage Element (SE) and they are accessible for further processing. For example – astonomical simulations - in order to understand immediately the evolution of the investigated protoplanetary disc we have developed a Visualisation Tool (VT) to visualize the final research outputs data and to preapare Virtual Reality scenas. In case of our gridified application the output data of the simulation located on the SE can be directly used as the input for the visualization. An unsolved question of the Solar System (SS) cosmogony is the origin of comets and minor bodies with respect to the SS evolution. Recently, the researchers try to bring a unified theory of the formation of small-body reservoirs in the SS: the Kuiper Belt, the Scattered Disc situated beyond the orbit of Neptune. In our application we developed a new inproved model for explaining the formation of the Oort Cloud. One has to assume dynamical evolution of a high number of particles under the gravitational influence of the giant planets: Jupiter, Saturn, Uranus, Neptune the Galactic tide and nearby passing alien stars. In our application we assumed 10038 test particles. It is several times more than in the previous simulations. Our extensive simulate required a very large computing capacity. To completing our model on a single 2.8GHz CPU would last about 21 years. Using the GRID infrastructure, the whole computation lasted 5 months. So, it was more than 40 times faster. The result of our simulation is dynamical evolution of orbits of test particles during the first giga year of the Solar System lifetime. Detailed study of this first giga year evolution results in a general agreement with the results of previously mentioned models as well as in new facts and questions. The simulation was realized as a sequence of parameter studies, where each sub-simulation was submitted to the grid as a separate parameter study. In our approach we tried to get as close as possible to the expectations of users, i.e. means to put the application code and input data into the grid, configure and start the processing and after the processing (with occasional checking of the progress) to download the output data. The main problem, when running the parametric simulation with a large number of jobs was the reliability of the grid infrastructure. The job management was rather time consuming due to the analysis of failed jobs and to their re-submission. Moreover the jobs, waiting at a site in a queue for a long time, were blocking the whole simulation. To overcome these problems, we developed an easy-to-use framework based on pilot jobs concept, that uses only services and technologies available in EGEE (Enabling Grids for E-science) infrastructure, grid middleware gLite and Bourne Shell scripting language. It consists of the pilot jobs – workers, and of an automatic job management script. Workers are running the application code in cycle with input datasets downloaded from a (SE) using RFIO (Remote File Access). After the completion of each sub-simulation step all results are stored in the reserved output area of the SE and they are accessible for further processing. The visualization tool is designed as a plug in module. Client asking for visualization is as a “visualization client”. Output data on the storage element are the inputs data for visualization jobs. The VT is composed of several modules, which are responsible for creating scenes and converting data to the visualizable format. The VT is designed as a plug-in module. The components generating rendering scenes are easy to exchange, according to the requirements of the given application. The final product of the VT includes a set of files containing data in the VRML (Virtual Reality Modelling Language) format.