ENABLING GRID TECHNOLOGIES FOR FUSION ACTIVITIES

PARTNERS

Three Federations have launched the project for using grid technologies for Fusion studies, intending the participation of the whole Fusion and Plasma Physics Comunittiy. The following partners are committed, up to now: South West Fedearatin (CIEMAT in Spain and IST in Portugal), CEA in France, Kurchatov Institute in Russia, KISTI in South Korea, Instituto de Fisica Universidade de Sao Paulo, Brazil, Integrated Tokamak Modelling (EFDA Activity).

INTRODUCTION AND MOTIVATION

The present time is very important since ITER device is about to be built in Europe and all the related activities are being launching at this time. We have the chance to propose grid technologies as a useful tool for ITER and Fusion related research activities.

EGEE cannot ignore this kind of developments that has a large potential utility for fusion activities. Especially taking into account the structure of Fusion community in EU.

The organization of Fusion Community in the countries belonging to EU is based upon the existence of agreements of EURATOM with an institution or a research institute in every country. The reminder of activities depends strongly on the dissemination efforts performed by such institute. Usually, there are a few large groups (typically three) and a number of small groups that work on Fusion in every country. For instance, SW is mainly based in two institutes associated with EURATOM: CIEMAT in Madrid and IST in Lisbon. TJ-II (the only stellarator working in EU is in operation presently in CIEMAT); CEA is the associated institution in France. Beyond the interesting present activities on Fusion performed by CEA, the appearance of French group is very important, since ITER will be built in Cadarache. Russian Federation has also important institutes that work on fusion, being Kurchatov one of the most important. The main plasma device in operation is T-10 tokamak and the main stellarator is L-2. They have a long experience in Fusion Physics and, because of that, there are a lot of groups disseminated by the country that work on Fusion.

It is clear that more associations will become interested in grid activities, since a large benefit can be obtained from these technologies for fusion research and development. In particular, the International Tokamak Modelling Project will get strong benefits from and should be involved in these developments.

Fusion community works with strong collaborative efforts among all the institutes all around the world and the interchange of information and data is mandatory. The Fusion experiments are expensive and must be considered as common facilities to be exploited by the community in order to save money and to allow synergetic efforts. The scientific and technical knowledge produced by all the research groups is shared by the community.

A new scenario will appear when ITER is ready. At least, the research groups belonging to the six present ITER-partners will be potential users of grid technologies for exploiting efficiently the device.

OBJETIVES OF DEVELOPMENT OF GRID TECHNOLOGIES FOR FUSION COMMUNITY

Two large fields must be considered: Computation and data analysis. And a more generic objective regarding data interchange and communication must be also taken into account. A new research line for the using of the grid should be opened inside EGEE.

During the first steps of using the grid, effort must be done to port some strategic applications that are used by Fusion community. Those applications can be used as a proof of concept of Grid technologies, which can be extended to more applications in the future.

Grid technologies are especially useful for problems that have a strong request of distributed computation, and there are a lot of them in Plasma Physics for Fusion. The following could be considered:

1) Kinetic models based on the following of single particles can be used for studying heating and transport. Every particle with a complicated dynamics can be followed in a 5D space in a single processor. A typical number of 10**9 particles are needed.
2) Turbulence estimations based on PIC models. Trapped Electron Modes (TEM) and Ion Temperature Gradient (ITG) models are candidate to explain a fraction of anomalous transport observed in magnetic confinement fusion devices. There are several computer codes based upon distributed computation that can be used for these calculations.
3) Estimation of diffraction effects on a heating microwave beam that crosses the plasma. This calculation can be performed by simulating the beam by the launching of thousands of rays that are independent among them.
4) Transport analysis using ASTRA (or any other transport) code: The thousands of plasma shots that are generated by the different devices can be analysed by studying separately all the shots in different computers. Up to know, scaling laws can only explain global confinement, with this kind of technique it will possible to relate local transport coefficients with global parameters.
5) Monte Carlo codes that allow Neutral Beam Heating estimations can be in the grid.
6) Particle source estimations relies also on Mote Carlo calculations. Therefore grid technologies are suitable for such problem.
7) Device Optimization: Different innovative concepts can be explored in a distributed way.

The distributed computation power that involves non-homogeneous resources (cluster, supercomputers, PCs, etc) can be very helpful for the future, when Fusion experiments are becoming more and more expensive. The main objective of grid research activities must be to show that grid technologies can be used to solve those problems and, therefore, a new thinking in solving Physics problems based on distributed calculation must be opened. In particular, making decisions in real time after a shot in a plasma confinement device like a tokamak depends on the running of several related codes. The Integrated Tokamak Modelling, that uses equilibrium, transport and heating codes, can obtain a high benefit of grid technologies. ITER shot parameters will be thoroughly analysed before performing the discharge in order that no risk is assumed and grid technologies are suitable for this kind of analysis. The indexation of application-specific parameters in conventional grid index services will be a final result.

The second objective is to show that relative data analysis is possible in the grid. A huge amount of data is generated by fusion devices, especially those concerning turbulence. The present tools for analysis, that includes Fourier transform, wavelets, etc. can be used in a distributed grid. Indeed, ITER data will need a lot of analysis effort to be exploited.

The experimental data must be accessible to the research community. The access to the data of several devices and the navigation by different database are nowadays a complicated task. Grid technologies could make feasible data sharing and interchange between the database of the different laboratories. The data access and the interconnection of the several database is also a key task to be developed in the grid.

Communication among researchers will be mandatory. Not only data and computer model sharing uis basic but real scientific discussions must be allowed by the technology. The grid and the network technologies must be developed.

PREVIOUS EXPERIENCE AND CAPABILITIES

There is a knowledge on grid and communication technologies in Fusion community. Some remote participation experiences, the development of Local Networks, etc, have helped to the community to keep in touch with this kind of techniques.

On the other hand, several partners that accompany Fusion Institutes have previous experience on using grid technologies and people belonging to those institutes have reached such experience working on High Energy Physics or Biomed.

WORK PROGRAMME

a. Experimental data exchange:
   i. Standardization of data storages interface (LCG2/gLite based)
   ii. Testbed: representstion of some native experimental data strorages
b. Experimental data indexation:
   i. Standardization of index service interface (LCG2/gLite standard): add indexation of application-specific parameters
   ii. Refactoring of conventional (LCG2/gLite) index service
c. Computations support:
   i. API for some high-level language (Python?) standardization and realisation
   ii. Application testbeds: devices optimization, etc
d. Experimental data processing:
   i. API for some high-level language (Python?) standardization and realisation

ii. Testbeds: experimental parameters automatic reconstruction

iii. Testbeds: simple or conventional user interface (visualization and processing tool)

to data and indexation services

e. Dissemination