SUPERCOMPUTING
Dedicated to Earth System Modelling

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DKRZ: Responsibilities

Climate simulations involve extreme demands on computing resources. Modern super-computers allow not only the simulation of mere physical processes, such as flow dynamics, radiation balance, heat exchange and wind effects on the oceans, but also the evaluation of chemical and biological coupling mechanisms. These computer capacities are usually not available at research institutes and universities.

On November, 11th, 1987 the German Climate Computing Centre (DKRZ) in Hamburg was founded as a national, non-profit service centre to give the German earth system research community the opportunity to simulate the climate not only qualitatively, but also quantitatively. Since its foundation, DKRZ provides:

- *the most modern high performance computing resources,*
- *leading edge data archiving facilities,*
- *high end visualisation facilities,*
- *infrastructure and competence in geo-informatics.*

DKRZ: Structure

DKRZ is a limited company (GmbH). Its shareholders are the Max-Planck-Society (55%), the City of Hamburg, being represented by the University of Hamburg (27%), the Alfred-Wegener-Institute for Polar and Marin Research (9%) and the GKSS Geesthacht (9%).

The annual operation costs of the centre are carried by the shareholders. Investment costs are provided by BMBF. Half of the DKRZ resources and services are at the disposal of its shareholders. The other half is allocated by a scientific steering committee to research groups based on scientific quality of proposals which depend on high computing facilities.

The new scientific and technical director of DKRZ, Thomas Ludwig, also holds a professorship for computer science at the University of Hamburg.

The New Facilities

In 2009 the DKRZ will move into a new building, which is funded with 26 million Euro by the City of Hamburg. In addition a new high performance computer and a new data archive will be installed at the new facilities, being funded by the Federal Ministry of Education and Research (BMBF) with further 34.6 million Euro.

The new supercomputer, an IBM Power6 system, delivers about 150 Teraflop/s (150 trillion floating point operations per second) in peak performance and will belong to the world-wide largest supercomputers being used for scientific purposes.

Scalability and Efficiency in the Multi-Core-Age

Until very recently the speed of a single CPU (central processing unit) doubled roughly every two years. This has come to an end for technical and physical reasons. The new rule of thumb says that the number of computational cores will double every two years.

„Climate modellers will have to learn how to use very large numbers of cores in parallel."

The new DKRZ computer will have 8000 cores, each having about the same computational power as one of the 200 vector CPUs of the previous system. Future applications which need even more computational power will require systems with much more cores.

„If, with a global atmosphere model, we wanted to achieve 1000 forecast days per day at a horizontal resolution of 1km, we would need to run it on more than 10.000.000 processing units in parallel."

Today nobody knows how to program such an application, how to handle the enormous data streams produced by it and how to pay for the power bill of such a machine.

Preparing for the (near) future

ScalES (Scalable Earth System Models) is a BMBF funded project led by DKRZ which started in January 2009. In this project we will identify bottlenecks, which inhibit efficient scaling of typical climate models and will implement prototype solutions in the „COSMOS" coupled earth system model. In particular, the project will address parallel I/O, load balancing, efficient parallel coupling of component models and efficient use of state-of-the-art computer architectures.

DKRZ runs one of the largest data bases worldwide, containing today already more than 10 PetaByte.

With the increasing computational power, the annual production rate of currently more than 1 PetaByte (red area) will increase considerably. In the near future, data production at DKRZ will reach world leading 10 PetaByte/year (yellow area).

DKRZ offers access to a high end visualisation server system as well as help and support with the intricate visualisation of data.

The background shows a short excerpt of the atmospheric model ECHAM5 written in the programming language FORTRAN90.

DKRZ systems at a glance:
- 250 IBM Power6 nodes
- 12 IBM Power6 I/O nodes
- 16 dual core CPUs each, thus altogether 8384 cores
- 18.8 GigaFlops/core, i.e. about 150 TeraFlops/s peak performance (150 trillion floating point operations per second)
- 20 TeraByte main memory
- 3 PetaByte disk (additional 3 PetaByte to be installed in 2011)

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