Interactive application support in the Int.eu.grid project

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Abstract. The consortium from 13 European countries is trying to improve functionality of Grid by developing and deploying an interoperable production-level e-Infrastructure for demanding interactive applications that will impact the daily work of researchers: distributed parallel (MPI) interactive computing and storage at the tera level, user friendly access through a Grid interactive desktop with powerful visualization, supporting virtual organizations at all levels - setup, collaborative environment, Grid enhancement of applications, execution and monitoring tools, discussion of results.
This paper brings an overview of the Interactive European Grid project and of one of its applications – Decision Support Tool for Environmental Assessment of Climate-Change driven Risks in Landscape.

1 Introduction

The Interactive European Grid (Int.eu.grid) project [1] started on 1 May, 2006 and will last for 24 months. The objective of the project is the deployment of an advanced Grid empowered infrastructure in the European Research Area specifically oriented to support the execution of interactive demanding applications. The consortium involves 13 leading institutions in 7 countries, with significant computing capacity and expertise in Grid technology.

While guaranteeing interoperability with existing large e-Infrastructures like EGEE [2] by providing basic common middleware services, the initiative will exploit the expertise generated by the EU CrossGrid project [3] to provide researchers an interactive and simultaneous access to large distributed facilities through a friendly interface with powerful visualization.

The Int.eu.grid project, while interoperable with EGEE, will focus on interactive use for medicine, environment, physics and other research areas (from robotics to archeology) where demanding interactive applications that can benefit from being grid-enhanced have been identified.

2 Project infrastructure

Grid infrastructure for the Int.eu.grid project will be based on Grid middleware developed in EGEE project [2] and will be interoperable with EGEE infrastructure. Moreover, it will contain tools and services provided by the Joint Research Activities of the Int.eu.grid project with focus on support for interactive applications from various research areas. The Int.eu.grid infrastructure will include more than 500 CPUs distributed at 12 different computing sites across Europe, in Spain, Portugal, Germany, Poland, Austria, Slovakia, and Ireland. The infrastructure is a successor of a Grid testbed developed within the scope of the project CrossGrid [3] and sites use the expertise gained from its operation. The operation of Int.eu.grid infrastructure is the main focus of SA1 activity (Service Activity), with the following specific tasks: accounting, helpdesk, VO management (Virtual Organization), security management, quality assurance, central services, monitoring, deployment coordination, middleware validation and network integration.

3 Project applications

In the first phase of the project applications in three reference research lines, namely with clear demand for grid-enhanced interactive use, are supposed: medicine, physics and environment.

The scope of medicine research applications will involve support for ultrasound computer tomography, including real-time data storage, virtual surgery for aneurisms and support for clinical VO (Virtual Organization).

Applications in physics will consider interactive applications in high energy physics, astrophysics, and fusion.

Applications for research on environmental modeling will address in particular the interactive applications for decision support [7], [8], [9]: meteorological, hydrological, hydraulic and pollution related problems. A deeper background for environmental modeling and one of these applications planned to be supported [10], [10], [12] is described in the following sections. Another environmental modeling application related to the assessment of radioactive pollution is presented in the separate paper for this workshop [13].

4 Environmental modelling applications

Understanding the Earth system is crucial to enhancing human health, safety and welfare, alleviating human suffering including poverty, protecting the global environment, reducing disaster losses, and achieving sustainable development. Observations of the Earth system are critical to advancing this understanding.

On February 16, 2005, 61 countries agreed to a plan that, over the next 10 years, it will revolutionize the understanding of Earth and how it works. Agreement for a 10-year implementation plan for a *Global Earth Observation System of Systems*, known as GEOSS [4], was reached by member countries of the *Group on Earth Observations* [5] at the Third Observation Summit held in Brussels. Nearly 40 international organizations also support the emerging global network. The GEOSS project will help all nations involved produce and manage their information in a way that benefits the environment as well as humanity by taking a pulse of the planet. GEOSS is envisioned as a large national and international cooperative effort to bring together existing and new hardware and software, making it all compatible in order to supply data and information at no cost. GEOS will yield a broad range of societal benefits, including:

- reducing loss of life and property from natural and human-induced disasters,
- understanding environmental factors affecting human health and well-being,
- improving management of energy resources,
- understanding, assessing, predicting, mitigating, and adapting to climate variability and change,
- improving water resource management through better understanding of the water cycle,
- improving weather information, forecasting and warning,
- improving the management and protection of terrestrial, coastal and marine ecosystems,
- supporting sustainable agriculture and combating desertification,
- understanding, monitoring and conserving biodiversity.

An integrated economic, social and environmental assessment of these nine benefit areas has not yet been carried out. To develop methodologies and analytical tools to perform benefits assessment is currently the objective of many, so called GEO-BENE (*Global Earth Observation Benefit Estimation: Now, Next and Emerging*), projects.

5 Environmental Assessment of Climate-Change driven Risks in Landscape – Decision Support Tool

The main objective of this application is the environmental modelling in agriculture and forestry to simulate environmental impacts (greenhouse gases emission and sequestration, drought stress, crop production, soil erosion, etc.) with respect to climatic scenarios and management-land use alternatives. The output environmental data should be consecutively processed in socio-economical assessment models.

The application has been developed within the scope of the INSEA project [6] whose goal is to develop an analytical tool to assess economic and environmental effects for enhancing carbon sinks on agricultural and forest lands. 13 organizations from several European countries are participating in the project. Recent studies illustrate that in spite of revolutionary technological advancements in carbon (C) emission-free energy, the goal of CO_2 stabilization will be difficult to achieve. Therefore, supplementary actions, such as manipulation of biogenic carbon sinks and sources, must be undertaken. Detailed studies show that changes of C pools in terrestrial ecosystems follow the basic law of conservation of matter and C accumulation in one element of the component of an ecosystem is balanced by losses in other components. The practical implication of this is that the net C-sinks enhancement can be verified if all C fluxes are accounted and the overall C exchange picture is clear. The C-sink enhancement is a goal the should be accomplished by cost competitive analysis in which social and environmental targets and consequences are introduced. A comprehensive and consistent C-sink assessment has to be built on a solid scientific concept embracing appropriate knowledge and independent observations from field experiments and national studies, and high quality auxiliary spatial data. All the way to spatially explicit socio-economic data, system and data integrity is an important requirement, together with the efficient application of data, such as GIS data related to topography, soil, vegetation, forest, inventory, and other land and landscape information. To provide a solid basis for assessment of both environmental and financial terms a data-knowledge infrastructure as a framework for generating the environmental parameters has been established.

To set the environmental variables the EPIC (Environmental Policy Integrated Climate) model is employed. EPIC presents bio-physical, deterministic, dynamic model capable of modelling the wide range of environmental indicators. It includes ten major components: weather simulation, hydrology, erosion-sedimentation, nutrient and carbon cycling, pesticide fate, plant growth and competition, soil temperature and moisture, tillage, cost accounting, and plan environment control. EPIC can be used to compare management systems and their effects on land quality. The model operates in daily time steps for long-term time periods, for hundreds of years if necessary.

Most of the data essential for modelling are spatially geo-referenced, represented as a regular grid of spatial and attribute elements – raster cells organized in columns and rows. The resolution (cell size) depends on the scale of data represented – 2-25m for local scale, 25-250m for regional scale, etc. The number of raster cells is defined by the extent of area of interest and can be relatively high; thus a powerful data management tool has to be developed. Individual cells are also assumed as the element for attribute information describing the landscape entity, where each attribute is represented by one raster layer. To avoid the complicated raster data processing the individual raster cells can be transformed into vector representation and attribute data are then stored in a separate relational database.

The application will be focused on the development of an integrated system including:

- constructing the data-knowledge infrastructure for EPIC model
- developing the data management tool to support the EPIC data-knowledge infrastructure
- parallelizing the EPIC model – data parallel according to the raster cells (80000-3mil.), and scenarios parallel
- testing the application for some predefined scenarios and areas of interest
- interactive interrupting of application and visualization of results after desired time periods.

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References

1. Int.eu.grid project: www.interactive-grid.eu
2. EGEE-II project: www.eu-egee.org
3. CrossGrid project: www.crossgrid.org
4. GEOSS system: www.epa.gov/geoss/
5. GEO group: www.earthobservations.org
6. INSEA project: www.iiasa.ac.at/Research/FOR/INSEA/
7. ŠIMO B., CIGLAN M., SLÍŽIK P., MALIŠKA M., DOBRUCKÝ M.: Mediterranean Grid of Multi-Risk Data and Models. In: Proc. of 1-st workshop Grid Computing for Complex Problems - GCCP 2005, VEDA, (2006) 129–134
8. HLUCHÝ L., HABALA O., ŠIMO B., ASTALOŠ J., TRAN V.D., DOBRUCKÝ M.: Problem-solving environment for flood forecasting. *Management of Environmental Quality: An International Journal*, Vol 15, No.3 (2004) 268–275
9. HLUCHÝ L., HABALA O., TRAN V.D., ŠIMO B., ASTALOŠ J., DOBRUCKÝ M.: Infrastructure for Grid-based Virtual Organizations. In: Proc.of International Conference on Computational Science, Part III, LNCS 3038, Springer-Verlag (2004) 124–131
10. BALKOVIČ J., SHMID E., SKALSKÝ R., BUJNOVSKÝ R., POLTÁRSKA K.: Evaluation of GHG sequestration potential on arable land under different land use - case study from the Baden-Wrttemberg region (in Slovak). Air Protection., KONGRES management s.r.o. (2005) 108–111
11. BALKOVIČ J., SHMID E., BUJNOVSKÝ R., SKALSKÝ R., POLTÁRSKA K.: Bio-physical modeling for evaluatiog soil Carbon sequestration potentials on arable land in the pilot area Baen-Wrttemberg (Germany), Agriculture (Nitra), Vol. 52, No.3 (to appear - 2006).
12. SKALSKÝ R., BALKOVIČ J., SHMID E.: Environmental assessment of climate-change driven risks in landscape-decision support tool (in Slovak). In: Proc. of 1-st workshop Grid Computing for Complex Problems - GCCP 2005, VEDA, (2006) 84–134
13. BARTOK J., GAŽÁK M.: Assessment of Radioactive Pollution. In: Proc. of EADC workshop Environmental Applications and Distributed Computing, VEDA, (in print - 2006)