EUFORIA: Grid and High Performance Computing at the Service of Fusion Modelling

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on behalf of Euforia collaboration

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Porto

Outline

- Project Objectives

- Members

- Structure of the project

- Work plan

- Related Work

- Fusion Plasma Simulation

Project objectives

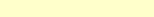**Bringing a comprehensive framework and e-infrastructure to the fusion modelling community oriented to the development of ITER**

- ❑ Deployment of Grid and HPC infrastructure
  - ➢ What does this mean exactly
- ❑ Adaptation and Optimization of Fusion Codes
  - ➢ Platform oriented Grid and/or HPC
- ❑ Development of advanced tools for
  - ➢ Workflow management
  - ➢ Visualization tools
  - ➢ Data mining

Consortium members
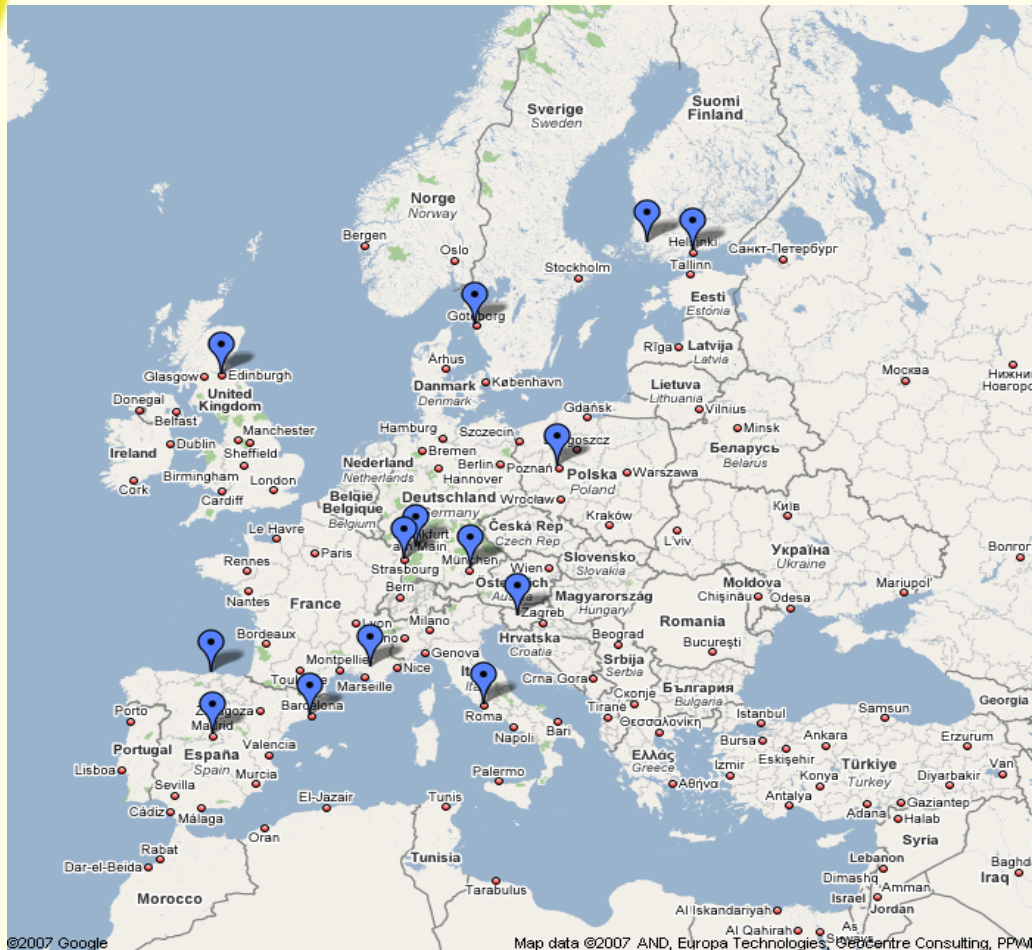
Legend:
- **Fusion Scientist** (blue)
- **Grid Computing Expertise** (red)
- **HPC Centers** (green)

Chalmers Univ. (Goteborg, Sweden)

CSIC (Santander, Spain)

CIEMAT (Madrid, Spain)

BSC (Barcelona, Spain)

CEA (Cadarache, France)

Strasbourg Univ. (Strasbourg, France)

FZK (Karlsruhe, Germany)

IPP (Munich, Germany)

EPCC (Edinburgh, UK)

CSC (Helsinki, Finland)

ABO Akademie (Helsinki, Finland)

PSNC (Poznan, Poland)

Univ. Liubjana (Liubjana, Slovenia)

ENEA (Italy)

Structure of the Project

- **Networking activities**
  - NA1 – Management
  - NA2 – User Documentation and Training
  - NA3 – Dissemination

- **Service Activities - Infrastructure deployment and Operation**
  - SA1 – Grid Infrastructure
  - SA2 – HPC infrastructure
  - SA3 – User Support for HPC and Grid activities

- **Joint Research Activities**
  - JRA1 – Adaptation of codes and tools for Grid Infrastructure
  - JRA2 – Adaptation of codes and tools for HPC infrastructure
  - JA3 – Physics Integration - Workflow orchestration tools
  - JRA4 –Visualization

Network Activities

- ## NA1 – Management:

  - Provide administrative and management services for the consortium as a whole

  - Provide Global (horizontal) coordination between and within the Joint Research and Service Activities

  - Coordinate the efforts of activity NA3 (Dissemination) and activity NA2 (Knowledge Dissemination)

  - Coordinate activities with EGEE, DEISA, ICEAGE and BELIEF using the already available contacts

  - Investigate possible liaisons with other EU and International Grid and HPC projects

  - Investigate additional sources of funding for the project through contacts with politicians and other decision makers

Network Activities

- ## NA2 – User Documentation and Training

  - Provide documents, FAQs and best practice information to users on the Grid and HPC infrastructure

  - Provide a comprehensive training programme for developers and users, including the development of a companion guide

- ## NA3 – Dissemination

  - To disseminate the purposes and benefits of Grid Computing and Supercomputing in the Fusion area, and of joining or using the EUFORIA infrastructure

  - To define the dissemination methods and message content for reaching each community

  - To provide dissemination materials adapted to the target audiences and make them available

  - To inform the scientific communities on how to get involved in the project

  - To bring directly potential users so that they may become EUFORIA users

  - To keep the communities informed of new improvements and functionalities

Service Activities

- ## SA1 - Grid Infrastructure Deployment and Operation

  - Deploy, maintain and operate the central services necessary to ensure the integration of the computing resources into a production Grid infrastructure capable of supporting serial and parallel applications

  - Coordinate the deployment, maintenance and operation of the Grid resources provided by the participating sites ensuring a robust, secure and dependable service

  - Provide support for Virtual Organizations and resource providers thus helping end-users, VO managers and site managers to achieve their goals and contribute to a successful usage of the infrastructure.

Service Activities

- SA2 - HPC Infrastructure

  - To provide [HPC] infrastructure support for the code optimization effort within JRA2

  - To provide run time access to supercomputers for feasibility tests for the HPC codes within the code platform

- SA3 - User Support for HPC and Grid Activities

  - To provide, through a single user interface, user administration, resource management, accounting, reporting and a central helpdesk for users of the service.

  - To provide support for a broad range of applications in porting and initial optimization of their applications on the EUFORIA infrastructure.

Joint Research Activities

- JRA1 - Adaptation of codes for Grid infrastructure

  - To port a set of sequential codes to the grid environment together with at least a few mixed sequential-parallel codes

  - To get experience in running the codes and managing the data produced by them within a work flow environment

- JRA2 - Adaptation of code for HPC infrastructure

  - To improve the parallel scalability of the computer codes

  - To optimise their performance on modern processor architectures

  - To adapt the codes so that they can be integrated into a single coupled framework through a workflow orchestration tool

Joint Research Activities

- The following codes have been identified as of potential interest for their adaptation:

  - BIT1 Kinetic 1D3V (1D in usual and 3D in velocity space) code for simulation of the plasma edge.

  - CENTORI Fully toroidal two-fluid, electromagnetic turbulence simulation code.

  - COREDIV Transport of energy code, main ions and impurity ions in the core and the scrape of layer regions.

  - EIRENE Kinetic neutral particle and line radiation transport code.

  - ELMFIRE Gyro-kinetic full-f particle code, with mostly global emphasis.

  - ERO Gyro-kinetic code for impurity transport in plasma.

  - ESEL Turbulence and profile evolution code at the outboard midplane in the SOL, using a fluid (ESEL) and gyrofluid (GESEL) approach.

  - SOL, using a fluid (ESEL) and gyrofluid (GESEL) approach.

  - GEM Gyrofluid code (GEM is local, GEMX is nonlocal, same infrastructure, similar scheme and programming, somewhat differently formulated equations).

  - GENE Nonlinear gyrokinetic code to investigate plasma turbulence.

  - ISDEP Kinetic theory of transport code based on Langevin Equations.

  - SOLPS Two codes (B2-Eirene) tightly coupled together based code.

  - TECXY 2D multifluid plasma and impurity transport in the tokamak edge simulating code.

  - TYR Drift Alfven plasma fluid turbulence and transport in flux-tube geometry code.
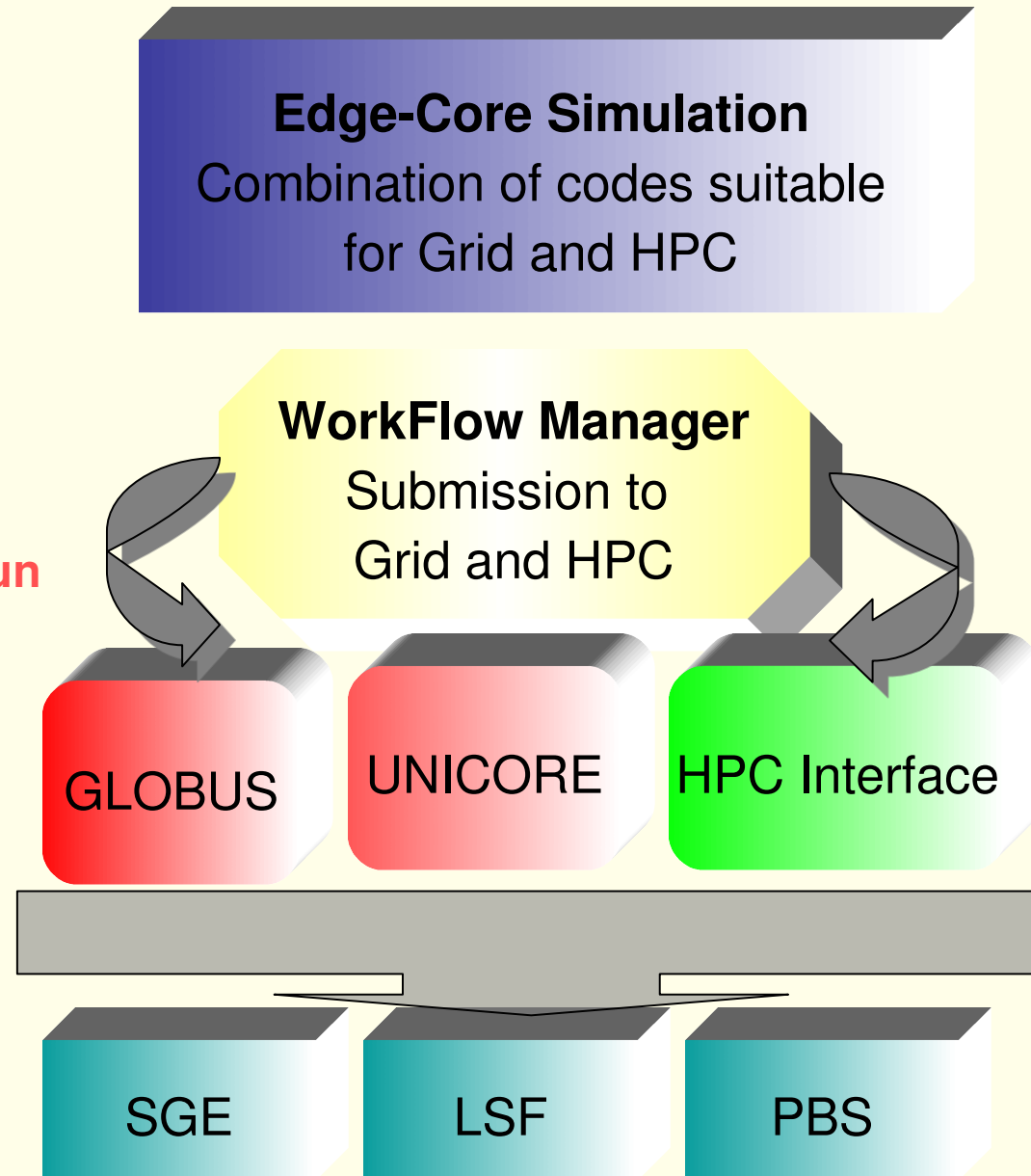
Joint Research Activities

- ## JRA3 - Workflow Orchestration

  - To schedule jobs on the GRID and HPC infrastructures together with jobs running on others computing facilities form a workflow orchestration tool that dynamically can link and launch the different computationally modules installed

  - To develop a single user interface to support user administration, user queries, resource management, accounting and reporting. This interface will fulfil the requirements of the SA3 users that will provide the related service

- ## JRA4 – Visualization

  - To provide a set of unified visualization tools available within the Kepler workflow to visualization data remotely available on a computational Grid

  - To implement more powerful visualization tools that can be used to post-process the computed data

  - To develop a new lossy wavelet based data compression tool in order to handle the very large amount of data generated by some of the codes

  - To develop specific visualization tools for a 4D or 5D distribution function
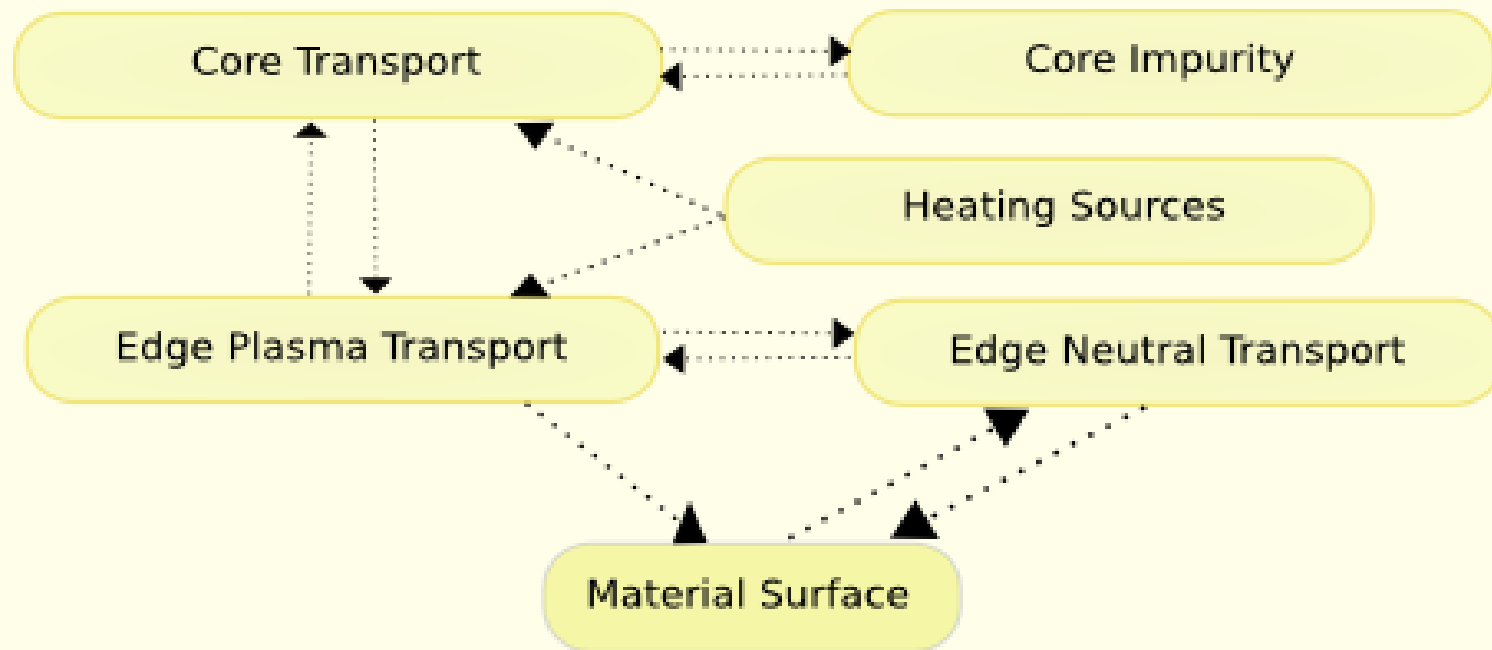
Work plan outline
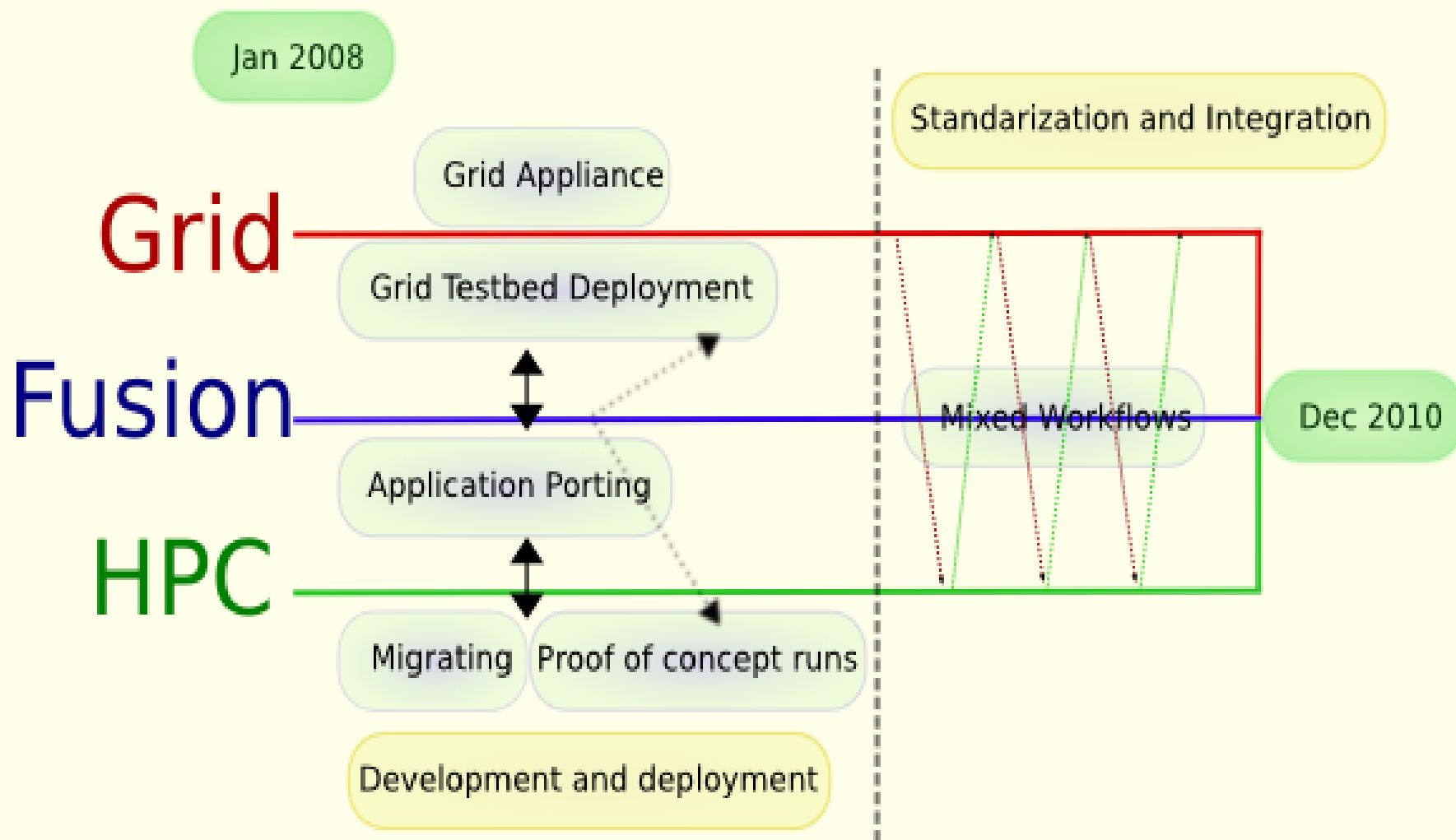
Standards related work

- **Adoption of Grid**
  - Virtualization of core services
  - Interoperation
- **User Services**
  - Data management
    - **Uniform access tools**
  - Membership handling
    - **Certified by EUGridPMA and run everywhere**
- **Complex Workflows**
  - Job submission
  - Resource Allocation
  - Data retrieval

Edge-Core Simulation
Combination of codes suitable for Grid and HPC

WorkFlow Manager
Submission to Grid and HPC

GLOBUS

UNICORE

HPC Interface

SGE

LSF

PBS

Fusion Plasma Simulation

Stages of simulation

Thanks for your attention!!

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