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Status of Planck simulations application

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1. Application context and scientific goals An accurate measure of the whole sky emission in the frequencies of the microwave spectrum and in particular of the Cosmic Microwave Background (CMB) anisotropies can have crucial implications for the whole Astrophysical community as it permits to determine a number of fundamental quantities that characterize our Universe, its origin and evolution. The ESA Planck mission is aimed to map the microwave sky performing at least two complete sky surveys with an unprecedented combination of sky and frequency coverage, accuracy, stability and sensitivity. The satellite will be launched in 2007 carrying a payload composed of a number of microwave and sub-millimetre detectors which are grouped into a high frequency instrument (HFI) and a low frequency instrument (LFI) covering frequency channels ranging from 30 up to 900 GHz. The instruments are built by two international Consortia which are also in charge of the related Data Processing Centres (DPCs). The LFI DPC is located in Trieste, the HFI DPC is distributed between Paris and Cambridge. In both Consortia, participation in the development of the data processing software to be included in the DPCs is geographically distributed throughout the participating Institutions. The overall Planck community is composed of over 400 scientists and engineers working in about 50 institutes spread in 15 countries, mainly in Europe but including also Canada and the United States. A fraction of this community, the one possibly involved with Grid activities, can be defined as the Planck Virtual Organisation (VO). During the whole of the Planck mission (Design, Development, Operations and Post- operations), it is necessary to deal with aspects related to information management, which pertain to a variety of activities concerning the whole project, ranging from instrument information (technical characteristics, reports, configuration control documents, drawings, public communications, etc.), to the proper organisation of the processing tasks, to the analysis of the impact on science implied by specific technical choices. For this purpose, an Integrated Data and Information System (IDIS) is being developed to allow proper intra-Consortium and inter-Consortia information exchange. Within the Planck community the term "simulation" refers to the production of data resembling the output of the Planck instruments. There are two main purposes in developing simulation activities:
2. during ESA Phase A and instrument Phases A and B, simulations have been used to help finalising the design of the Planck satellite's P/L and Instruments hardware;
3. on a longer time-scale (up to launch), simulated data will be used mainly to help develop the software of the data processing pipeline DPCs, by allowing the testing of algorithms needed to solve the critical reduction problems, and by evaluating the impact of systematic effects on the scientific results of the mission, before real data are obtained.
   The output of the simulation activity is Time-Ordered Information (TOI), i.e. a set of time series representing the measurements of the scientific detectors, or the value of specific house-keeping parameters, in one of the Planck instruments. TOI related to scientific measurements are often referred to as Time-Ordered Data (TOD). Common HFI-LFI tools have been built and integrated in order to build a pipeline system aimed at producing simulated data structures. These tools can be decomposed in several stages, including ingestion of astrophysical templates, mission simulator, S/C simulator, telescope simulator, electronics and on-board processing simulator. Other modules, such as the cooling system model, the instruments simulators and the TM packaging simulator, are instrument-dependent. It should be noted that the engine integrating all the tools has to be flexible enough in order to produce the different needed forms or formats of data.

The Planck Consortia participate to this joint simulations effort to the best of their scientific and instrumental knowledge, providing specific modules for the simulations pipeline. For each Consortium the code allowing to produce maps and time-ordered sequences out of simulated microwave skies is the one jointly produced for both Consortia: data simulated by HFI and LFI are therefore coherent and can be properly merged. To the output data of the common code (timelines) an additional LFI-specific code is applied to simulate on-board quantisation and packetisation, in order to produce streams of LFI TM packets.
The goal of this application is the porting of the whole simulation software of the Planck mission on the EGEE Grid infrastructure.

4. The grid added-value
   Planck simulations are highly computing demanding and produce a huge amount of data. Such resources cannot be usually afforded by a single research institute, both in terms of computing power and data storage space. Our application therefore represents the typical case where the federation of resources coming from different providers can play a crucial role to tackle the shortage of resources within single institutions. Planck simulations take great advantage from this as a remarkable number of resources are available at institutions collaborating in the Planck VO, so they can be profitably invested to get additional resources shared on the Grid. The first simulation tests have been carried out on the INFN production Grid in the framework of the GRID.IT project. A complete simulation for the Planck/LFI instrument has been run on a single, dual-CPU, workstation and on Grid involving 22 nodes, one for each detector of the LFI instrument. The gain obtained by using the Grid was of ˜15 times.
   Another added value coming from the Grid is its authentication/authorization mechanism. Planck code as well as data are not public-domain; we need to protect the software copyright; data moreover are property of the Planck P.I. mission. The setup of a Planck VO makes possible to easily monitor and control accesses to both software and data without the need of arranging tools already available in Grid.
   Last but not least a federation of users within a VO fosters the scientific collaboration, an added value of key importance in Planck given that users who collaborates to the mission are spread all over Europe and United States.

5. Experiences and results achieved on EGEE
   Due to some initial issues in the start up process of the Planck VO, we were not able to fully exploit the big amount of potential resources available for our application so far. The Planck VO has proved to be quite difficult to manage; the start up process, in particular, has been slowed down by some difficulties in the interactions between the local Planck VO managers and the respective ROCs. To overcome these issues and make the Planck VO fully operative in a short time on-site visits to Planck VO sites are foreseen in order to train local managers in setting up and maintaining the Planck VO node and even local potential users to foster the usage of the Grid technology for the Planck application needs.

6. Key issues for the promotion of the GRID technology
   On the basis of our experience with the astrophysical community a special effort is requested to spread the Grid technology and make potential users fully aware of the advantages in using it. User tutorials can be extremely helpful to achieve this goal. Even the preparation of a suite of Grid oriented tools is of key importance like Grid portals and Grid Graphical User Interfaces to make users able to interact with the Grid in an easy and transparent way and to hide some complexities of the underlying technology.

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