PROCEEDINGS OF SCIENCE

The EU-IndiaGrid Project

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EU-IndiaGrid2 - Sustainable e-infrastructures across Europe and India capitalises on the achievements of the FP6 EU-IndiaGrid project and huge infrastructural developments in India. EU-IndiaGrid2 will further the continuous e-Infrastructure evolution in Europe and India, to ensure sustainable scientific, educational and technological collaboration across the two continents. In particular the Large Hadron Collider (LHC) program represents one of the unique science and research facilities to share between India and Europe in the field of Scientific Research in general and in the ICT domain in particular. The Indian partners in the project represent both the ALICE and the CMS communities actively engaged in the LHC program. The role of the EU-IndiaGrid project in this specific activity has been widely recognised within the European Commission and the Indian Government and EU-IndiaGrid2 will continue its action in sustaining this community. The project, approved within the call FP7-INFRASTRUCTURES-2009-1, started on January 2010 with a duration of 24 months. This article aims at providing an overview of the EU-IndiaGrid and EU-IndiaGrid2 activities in the context of the Indian e-Science scenario.

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1. Introduction

The EU-IndiaGrid project was funded by the European Commission under the Research Infrastructures Programme. Its goal was making available a common, interoperable Grid infrastructure to the European and Indian Scientific Community, in order to support existing EU-Indian collaborations in eScience and promoting new ones. The EU-IndiaGrid Consortium saw the participation of Premier European and Indian Institutes with consolidated collaborations on worldwide projects. The project started on October 2006 and successfully ended on January 2009. In the judgement of the Reviewers the project not only *achieved its objectives and technical goals but even exceeded expectations* and its results were considered as *basis for future collaborations between EU and Indian eScience organisations.* The level of recognition for the project activity was confirmed, in the ACAT 2010 opening speech by Dr Kakodkar, former Department of Atomic Energy Secretary in the Government of India, who highlighted the projects successes and the relevance of is its activity for Euro-India scientific cooperation. These results were possible thanks to the strong commitments of several premier Indian partners and their leading role in the exceptional Indian progress on e-Infrastructures during the project lifetime. This progress was strongly motivated by the activity of several scientific communities and in particular by the communities related to LHC. In the following sections we will review the network and grid infrastructure scenario in India together with the specific EU-IndiaGrid project activity.

2. Indian e-Infrastructures scenario

In this section we discuss both the network and the grid infrastructure scenario which had, in the last few years a remarkable evolution.
The most prominent landmarks in the connectivity area since 2006 have been:

- The establishment of the 45 Mbps ERNET - GÉANT link and routing of regional WLCG data to CERN and subsequently EU-IndiaGrid traffic to EGEE in 2006;
- The establishment of a dedicated 1 Gbps TIFR-CERN link for LHC research in 2008 and peering with GÉANT in 2009;
- The establishment of the National Knowledge Network (NKN) in April 2009;
- The connectivity of the TransEurasia Information Network (TEIN3): 2.5 Gbps Geant link to India in February 2010.
- The approval from Government of India of the full National Knowledge Network Plan in March 2010 with a budget of about 1 Billion euro.
- The establishment of the Indian Grid Certification Authority, recognised by APGRIDPMA, by CDAC.
- The GARUDA transition for Proof-of-Concept to Foundation Phase, in April 2008 and currently is in the third phase namely Grid Technology Services for Operational Garuda.

Three of these milestones, namely the NKN start-up, the participation of India to the TEIN3 project, and the establishment of the Indian Grid Certification Authority, were marked by Dr R. Chidambaram, Principal Scientific Adviser to the Government of India, as crucial developments for Indian research: "*The successful working of the initial phase of the multi-gigabit NKN, Indian Certification Authority, and participation in TEIN phase 3 are some of the important building blocks for supporting virtual research communities in India and their collaboration work with other countries.*" In the sections below we will provide a brief description of NKN and TEIN3 initiatives together with an overview of the Indian National Grid Initiatives.

2.1 National Connectivity the National Knowledge Network Plan

The objective of the National Knowledge Network is to bring together all the stakeholders in Science, Technology, Higher Education, Research & Development, and Governance with speeds of the order of 10s of gigabits per second coupled with extremely low latencies. NKN will interconnect all institutions engaged in research, higher education and scientific development in the country, over a period of time. It would enable use of specialized applications, which allow sharing of high-performance computing facilities, e-libraries, virtual classrooms, and very large databases.

In the initial phase of NKN, with 15 Core locations and about 57 institutes covering leading national R&D labs and educational institutes have been connected at varying bandwidths of 100 to 1000 Mbps. In the final phase of NKN, around 5000 leading national academic and research institutes are going to be connected. On March 2010 the Government of India approved the full National Knowledge Network Plan in March 2010 with a budget of about 1 Billion euro. NKN with its multi-gigabit, low-latency, OFC-based backbone is acting as national transport for all existing networks. The Indian grid initiative GARUDA is riding on NKN as on today. The regional WLCG in India is going to be migrated to NKN. Education, Grid Computing, Agriculture and e-Governance are the main applications identified for implementation and delivery on NKN. Concerning Sustainability it must be stressed that NKN has been proposed as national programme. The network will be sustained through continuous government funding. The present Government approval established the funding for a period of 10 years. In the design philosophy of NKN, high speed connectivity to global research networks has been also envisaged (see below).

2.2 International Connectivity: India in TEIN3

The Trans-Eurasia Information Network (TEIN) initiative was launched at the Asia Europe Meeting (ASEM) Summit in Seoul in 2000 to improve Euro-Asian research networking. India joined with its phase 3 (TEIN3) in 2009.

As part of TEIN3 project, a TEIN3 Point Of Presence has been co-located at ERNET POP at Mumbai and it is acting as hub for connecting research networks in South Asia, except Pakistan. From Mumbai, two high speed links of 2.5 Gbps each has been commissioned to Europe and Singapore and are now operational providing direct connectivity to GEANT and

TEIN3 POP at Singapore. This way now, with TEIN3, India is now acting as hub for connectivity between Europe and Asia-Pacific countries.

2.3 Indian National Grid Initiatives

In India, two main Grid Initiatives have been taken at Government level: Regional WLCG set up by the Department of Atomic Energy (DAE) in coordination with the Department of Science & Technology (DST) and GARUDA National Grid Initiative. Both of them established a fruitful collaboration with the EU-IndiaGrid project and its successor EU-IndiaGrid2.

Fig. 1. Map of GARUDA and LCG sites

2.3.1 The Worldwide LHC Computing Grid in India

The Large Hadron Collider (LHC) built at CERN near Geneva, is the largest scientific instrument on the planet and it just started its data-taking phase. In full operation it will produce roughly 15 million Gigabytes of data annually, which thousands of scientists around the world will access and analyse. The mission of the Worldwide LHC Computing Grid (LCG) project is to build and maintain a data storage and analysis infrastructure for the entire high-energy physics community that will use the LHC. The Indian Department of Atomic Energy (DAE) is actively participating to the scientific program taking active part in CMS and ALICE

experiments, devoted to find answers to the most fundamental questions at the foundations of matter constituents. The data from the LHC experiments will be distributed around the globe, according to a four-tiered model. Within this model, to support researchers with required infrastructure, India has also setup regional Tier-2 centres connected to CERN. In India there are two Tier2 centres: one for CMS in TIFR Mumbai and one for ALICE at Saha-VECC Kolkata. These centres provide access to CMS & ALICE users working from Tier III centres of Universities and national labs and LCG Data Grid services for analysis. TIFR is presently connected to CERN at 1 Gb/s and very soon it will exploit the 2.5 Gb/s TEIN3 link. Now TIFR & VECC are also being connected through NKN at 1 Gb/s for migration to NKN.

2.3.2 GARUDA: the National Grid Initiative of India

GARUDA India National Grid Initiatives (http://www.garudaindia.in/) is a collaboration of scientific and technological researchers on a nationwide grid comprising of computational nodes, mass storage and scientific instruments. It aims to provide the technological advances required to enable data and compute intensive science for the 21st century.

C-DAC, one of EU-IndiaGrid's main partners, ensures progressive evolution and durable integration as manager of the Indian National Grid Initiative and from the start of its activity the EU-IndiaGrid project established an excellent collaboration with GARUDA.

GARUDA has transitioned form the Proof of Concept phase to the Foundation Phase in April 2008 and currently is in the third phase namely Grid Technology Services for Operational Garuda. This phase is approved for three years ending in July 2012. In this phase, National Knowledge Network is providing the communication fabric for GARUDA. The GARUDA project coordinator, CDAC established for the first time, in November 2008, recognized by the Asia-Pacific Grid Policy Management Authority (http://ca.garudaindia.in), which allows access to worldwide grids for Indian Researchers.

2.4 EU-IndiaGrid and EU-IndiaGrid2 project activity

As discussed in the sections above during the period of the EU-IndiaGrid project activity and right at the start of EU-IndiaGrid2 e-Infrastructures in India marked a considerable progress. The leading responsibilities of EU-IndiaGrid Indian partners and the project bridging role between European and Indian e-Infrastructures gave to EU-IndiaGrid project the opportunity to be at the core of this development and to effectively contribute at improving cooperation between Europe and India in this domain.

A specific effort was dedicated to the support of several user communities including Biology, High Energy Physics, Material Science, and Earth & Atmospheric Sciences.

For each user community specific applications were deployed on the grid infrastructure and each application was supported by a collaboration of European and Indian partners. A comprehensive overview of all applications main results was presented at the 3rd IEEE Conference on e-Science and Grid Computing with a keynote speech [1] and specific contributions for all applications [2].

In particular the activities related to the High Energy Physics applications were fully integrated in the framework of the Worldwide LHC Computing Grid Collaboration with particular concern with the ALICE and CMS experiments active in India. The grid

infrastructure made available by the project to the users was based on resources distributed across Europe and India. Over 180.000 jobs were executed corresponding to about 25 cpu time years and 45 Wall Time years.

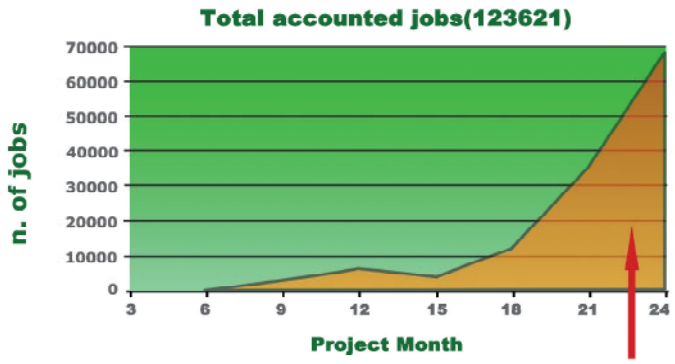

Fig. 2. The picture illustrates the growth in usage of the EU-IndiaGrid infrastructure by applications during the lifetime of the project in terms of jobs executed.

The increase of usage of the EU-IndiaGrid infrastructure, reported in figure 2 above, combined with scientific results obtained and presented at relevant international conferences or published on journals represent a clear measure of success of the user communities activity. The project Workshops and Conferences dedicated to the different applications were an important vehicle for the dissemination of results and for fostering the adoption of grid technology toward the scientific community and not only. In addition, supporting and addressing the problem of the interoperability at the application level further contributed to promote the use of advanced grid technology, and the cooperation between different projects and Institutes. Applications and user communities behind can thus be regarded as a key to sustainability, and they can help motivating the investment in e-Infrastructures.

In conclusion EU-IndiaGrid significantly improved the interoperability between Indian and European Grid infrastructures. Its contribution is brought forward EU-Indian collaboration in e-Science and effectively mobilising actors on both sides, with clear benefits in a variety of scientific disciplines. In particular it played a key role in fostering the co-operation between the the Indian National Grid Initiative, the regional component of WLCG and the European counterparts. This “bridging” role between European and Indian grid infrastructure has now the opportunity to improve, thanks to the recently approved plan for a multi-gigabit, low latency e-infrastructure: National Knowledge Network (NKN).

EU-IndiaGrid2, started on January 2010, will leverage on the EU-IndiaGrid project achievements and the strong cooperation links established with the foremost European and Indian e-Infrastructure initiatives paving the way for successful sustainable cooperation across European and Indian e-Infrastructures.

References

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