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W H I T E P A P E R O N L E S S O N S L E A R N E D

This document overviews the lessons learned by the EU-IndiaGrid2 Project. It shows the major achievements and what the project considers as the key aspects for the success. Critical points and difficulties encountered will also be examined.

C O N T E N T S

1.   INTRODUCTION

EU-IndiaGrid2 - Sustainable e-infrastructures across Europe and India is a Coordination & Support Action project funded within the FP7 INFSO Research Infrastructures Programme of the European Commission. Leveraging on the former EU-IndiaGrid project achievements and the strong cooperation links established with the foremost European and Indian e-Infrastructure initiatives, EU-Indiagrid2 paved the way for successful sustainable cooperation across European and Indian e-Infrastructures.

The project effectively supported a set of scientific applications, strategic for Euro-India cooperation, in the exploitation of the major European e-Infrastructures. Four application areas were identified: Climate change, High Energy Physics, Biology and Material Science. Seismic hazard assessment and neuroscience were identified as new areas of interest during the course of the project.

EU-IndiaGrid2 focused on four main objectives:

O1) Consolidate & enhance cooperation between European and Indian e-Infrastructures for the benefit of EU-Indian collaboration in e-Science;

O2)   Support specific user communities in the exploitation of grid infrastructures in areas strategic for EU-Indian collaboration, for example, biology & material science, climate change, high energy physics;

O3) Ensure a sustainable approach to e-Infrastructures across Europe and India through dissemination actions, meetings & workshops;

O4) Foster and enhance cooperation with other European Initiatives in the Asian region and worldwide.
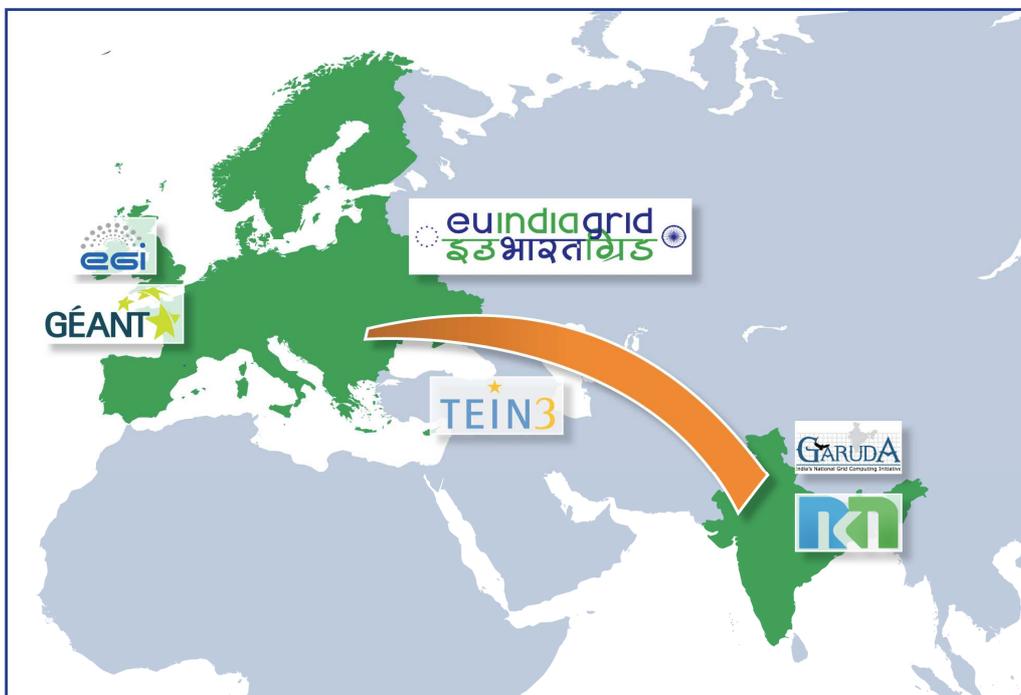

Figure 1 EU-IndiaGri2: a bridge between European and Indian e-Infrastructures

The project was coordinated by INFN, the Italian National Institute of Nuclear Physics, and the consortium encompasses other 15 partners, 10 from India, 4 from Europe and 1 international organization. EU-IndiaGrid2 database of contacts has grown up to 845 contacts dealing with biology (more than 140 contacts), material science (around 350 contacts), and more than 500 contacts working or interested in EUIG2 climate change research activities. The 500 contacts coming from academia and research organizations represent the core users and stakeholders of e-Infrastructures and will continue investing their effort in EU-IndiaGrid and related e-Infrastructures, in the mutual sharing of infrastructures at international level and towards a better interoperation of grid infrastructures. Moreover more than 100 government and public administrations representatives were involved during the project lifetime. Apart from new applications High Energy Physics continued to play major role in exploitation of infrastructures like the European laboratory for Particle Physics (CERN) where the role of India is becoming more and more significant.

The Grid framework provided access to large data collections, very large scale computing resources and remote facilities. The use of European Synchrotron Radiation Facility from Indian Institutions by protein crystallographers to collect successfully good quality diffraction data could be considered as major achievement. It reflected the scientist's capability to remotely plan, initiate and monitor experiments for protein crystallographic structure determination by applying high throughput distributed technologies. (The bridge between Europe & India via high bandwidth TEIN3/GEANT connectivity)

This paper comments the outcomes of EU-IndiaGrid2, drawing the lessons learned along the course of the project with the view to consolidate the long-term perspectives of the cooperation established between European and Indian e-Infrastructures.

2. EU-INDIAGRID2 CONSOLIDATED THE COOPERATION BETWEEN EUROPEAN AND INDIAN E-INFRASTRUCTURES

EU-IndiaGrid2 project launch occurred in conjunction with the India-EU Workshop on Research Infrastructures held at the Indian Institute of Technology, New Delhi on 11 January 2010. From that date onwards and over 2 years of work, EU-IndiaGrid2 contributed in a consistent way to improve the exploitation of Research Infrastructures for the benefit of science between Europe and India.

Figure 2 Alberto Masoni EU-IndiaGrid Project Coordinator, Dr Chidambaram, Principal Scientific Advisor to the Government of India and Member of Government Cabinet, Dr Philippe de Taxis du Poet, representing the European Union and Professor Surendra Prasad, Director IIT Delhi, at the EU-IndiaGrid2 Launch Event.

The project progress towards this objective can be summarised in a number of concrete achievements listed below.

Active contribution at the **India-EU Workshop on Research Infrastructures**, January 2010, Delhi

Effective cooperation with GARUDA National Grid Initiative and NKN, Indian National Knowledge Network, with European Grid iniatives EGI[1], EMI[2], OGF[3], TEIN3[4], WLCG[5], setting conditions for cooperation with PRACE[6] and India on

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[1] European Grid Initiative, www.egi.eu/

[2] European Middleware Initiative http://www.eu-emi.eu

[3] Open Grid Forum www.ogf.org/

[4] Third generation of the Trans-Eurasia Information Network http://www.tein3.net/

[5] Worldwide LHC (Large Hadron Collider at CERN) Computing Grid http://lcg.web.cern.ch/lcg/

[6] Partnership for Advanced Computing in Europe Initiative http://www.prace-project.eu/?lang=en

Supercomputing initiatives.

Active contribution at the **policy dialogue** between e-IRG and the Indian e-infrastructure management

Active contribution at **the EU-India policy dialogue on e-Infrastructures**, paving the way for cooperation on e-Infrastructures for **Neuroscience**. (August 2011, Delhi – India) Participation at the Workshop to Develop a Worldwide e-Infrastructure for Computational Neuroscientists to Fight Alzheimer's Disease, Geneva, International Telecommunication Union (ITU), United Nations February 2012

More than 800 European & Indian contacts from academia and research, public administrations and international initiatives involved in EU-IndiaGrid2 project activities.

As a further measure of the project success we quote **Dr Chidambaram, Principal Scientific Advisor of the Government of India and member of Government Cabinet** who referred to EU-IndiaGrid2 as

"an excellent example of EU India collaboration underpinning all areas of science"

2.1.   Lessons learned

Establishing a shared vision of e-Infrastructures strategy between European and Indian Governments is of fundamental importance to ensure mutual growth in R&D, leveraging on European knowledge and Indian economic and human resource potential.

Establishing concrete & direct links with both Policy Makers and final stakeholders is essential to favor the communication and the dissemination of results

Policy cooperation must be followed by a **concrete set of actions** to ensure adequate progress of Euro-Indian research programmes

A strong cooperation with the relevant e-Infrastructure initiatives such as GÉANT, EGI, PRACE, GARUDA, NKN, EMI and their interconnection provided by networks such as the TransEurasia Information Network project (TEIN3) are fundamental to reinforce EU-Indian bilateral cooperation in

3. EU-INDIAGRID2 PROVIDED A DEDICATED SUPPORT TO USER COMMUNITIES

If we represent the project activity as a building, the e-infrastructures technological support symbolises the pillars, while the support to scientific communities represents the lintel in the project architecture (see picture).

Figure 3 EU-IndiaGrid2 project architecture
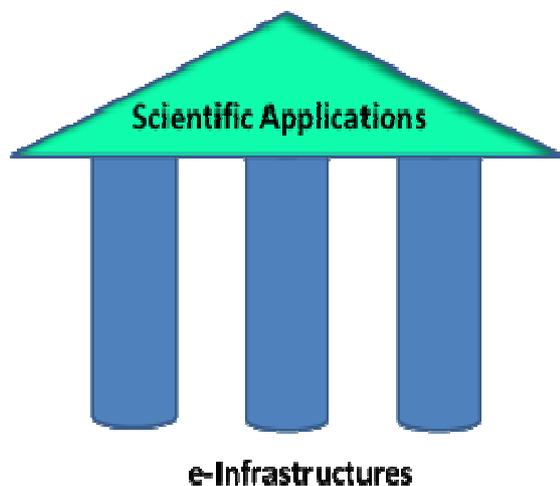
The project actively supported the interoperability of the main network and grid infrastructures across Europe and India while simultaneously ensuring the benefit of Euro-India strategic research cooperation initiatives.

This vision, where research applications rely on a core of services provided by e-Infrastructures fully matches the European Commission Research Infrastructures Work Programme, whose objective is *to optimise the use and development of existing research infrastructures in all fields of science and technology, including e-Infrastructures.*

This shared vision, by Europe and India, of e-Infrastructures policy is quoted as one of the key points among the Lessons Learned reported in the previous section.

Figure 4 Eu-IndiaGrid2 graphical representation

EU-IndiaGrid2 focused on four application areas strategic for Euro-India research cooperation:

- **Climate change**
- **High Energy Physics**
- **Biology**
- **Material Science**

In addition, over the course of the project, further areas of interest were identified. In particular **seismic hazard assessment** produced interesting results, as reported in the section below. A further promising field is represented by **neuroscience** applications.

Specific support activities were set-up for each particular application area identifying technical and scientific issues and deploying actions for effective solutions. User support ranged from the involvement of new users and associated computational applications up to specific actions to reach scientific goals through the enhanced and enlarged user community promoted by the project itself. For each user community a collaboration team was built with European and Indian Institutes involved on a case-by-case criteria. This approach proved to be extremely effective and excellent teamwork experience was established among the partners. Training Activities in favour of the user communities were performed during the course of the project.

Among the highlights in these domains we mention:

A new **climate model ported on the Grid** for the benefit of Monsoon studies[7]

Exploiting **NKN-TEIN3- GÉANT connectivity** for High Energy Physics analysis by Indian research community at the CERN Large Hadron Collider[8]

A new grid environment created for **biology simulations**[9]

Parallel jobs on the grid made easier for **material science applications**[10]

Remote access of European Laboratories from Indian Research centres made easier using NKN-TEIN3- GÉANT connectivity[11]

The relevance of the application results and its full recognition by policy makers can be considered as a success of the project activity.

> *"I am happy to learn about the second phase of the EU-IndiaGrid2 project – Sustainable e-Infrastructures across Europe and India. The first phase has benefited immensely a variety of scientific disciplines including biology, earth science, material science and the Indian collaboration for the Large Hadron Collider".*
>
> **Dr R. Chidambaram** (Principal Scientific Adviser to the Government of India and member of the Government Cabinet – Letter to Alberto Masoni, EU-IndiaGrid2 Project Coordinator

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[7] http://www.euindiagrid.eu/index.php/earth-a-atmospheric-sciences/use-cases-climate-change

[8] http://www.euindiagrid.eu/index.php/high-energy-physics/use-cases-high-energy-physics

[9] http://www.euindiagrid.eu/index.php/biology/use-cases-biology

[10] http://www.euindiagrid.eu/index.php/material-science/use-cases-material-science

[11] http://www.euindiagrid.eu/index.php/material-science/use-cases-material-science?start=2

3.1. Lessons learned

There is often **resistance** by researchers to porting their applications on the grid or to initiating strong dependences from e-Infrastructure services (e.g. network) because of the initial investment and the

Continuous support is essential to guarantee an effective use of e-Infrastructure resources by scientific applications

The best approach is to provide **grid infrastructure test-bed** access at the beginning but to address the users and support their access to large e-Infrastructures initiatives as GÉANT, EGI, NKN,GARUDA

A critical point is the ratio between the number of people approached by training or dissemination activities and the **effective users**. An analysis of the limited extent of this result led to the following conclusions:

- In a relevant number of cases, despite the temporary success of application porting, **the users do not continue their activity** when the support decreases or disappears;
- Despite the efforts, the **complexity of the procedures** to access the grid services still represent an obstacle and only a limited number of researchers are sufficiently motivated to become real users;
- In some cases researcher groups decide to "**delegate**" only one or two people as "interfaces" to the grid services. This is not necessarily a weak point but it contributes to explain the

4. EU-INDIAGRID2 DISSEMINATION ACTIONS CONTRIBUTED TO INTERNATIONAL COOPERATION ENHANCEMENT, PROJECT PROMOTION AND TEAM BUILDING AMONG THE PARTNERS

EU-IndiaGrid2 successfully mobilised user communities through participation to high-level events and conferences, targeted dissemination documents and focused support activities in conferences workshops and training events, playing an instrumental role in strengthening Euro-India cooperation on e-Infrastructures and expertise in research infrastructures. Through a series of effective & continuous communication activities the project achieved high visibility both among the general public and policy makers.

EU-IndiaGrid2 organised 8 events focusing on climate change, high-energy physics, material science as well as one event introducing seismology & neuroscience and a variety of dissemination activities targeting EU and India e-Science communities.

The variety of training programmes, visits and materials produced and conference and training workshops organised were effective in supporting the specific user communities in biology, material science, high energy physics and climate change application areas
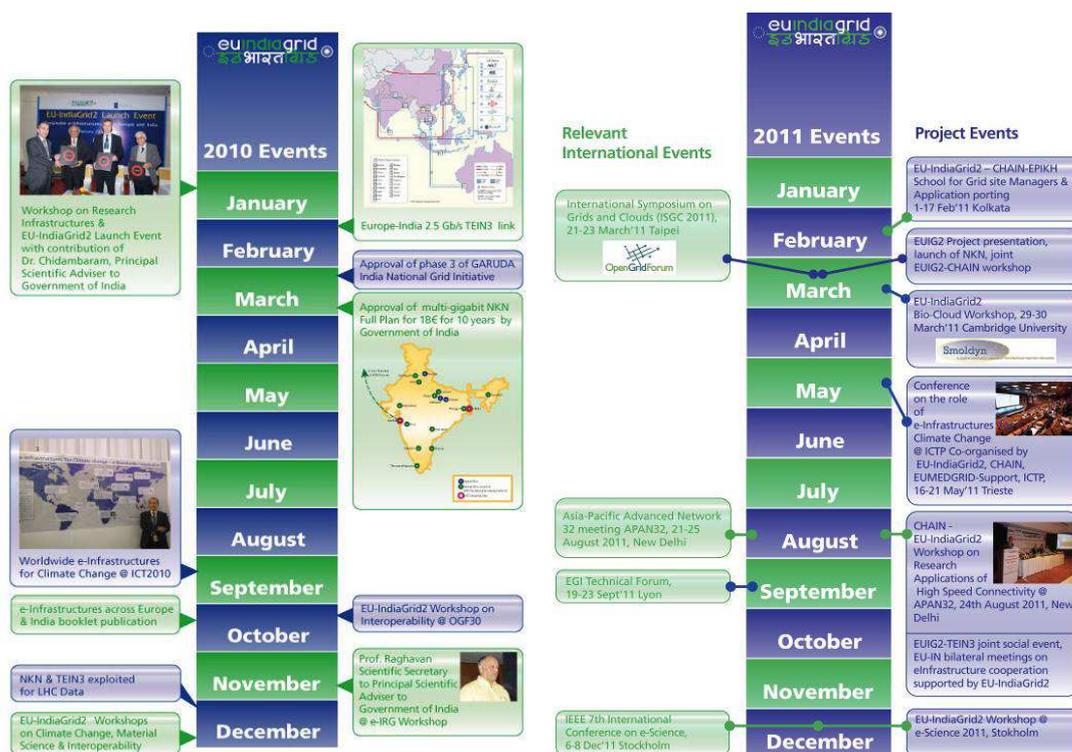

Figure 5 EU-IndiaGrid2 events

The global impact of these workshops include:

> **Support to applications** in exploiting connectivity services offered by NKN, TEIN3 and GÉANT. The integration of the MPI attributes job submission: since July 2011 the long awaited MPI attributes semantic is part of the standard EMI (ex gLite) grid middleware distribution thanks to the active contribution of EU-

IndiaGrid2 over its lifetime.

> **The integration of VOMS service with GARUDA submission portal.**

> **The progress in interoperability achieved thanks to the exploitation, in a real resource production environment, of the RegCM application on both GARUDA and EGI infrastructures**

> **The integration of the project interoperability effort within the international cooperation with the CHAIN and IGE projects, with a development of synergies, led to an effective use of the resources and paved the way for the interoperability scenario to continue beyond the project lifetime.**

4.1. A dedicated conference on the Role of eInfrastructure for Climate Change was very successful both for scientific outcomes and policy networking

The "Conference on the Role of e-Infrastructure for Climate Change", held in May 2011 at the Abdus Salam ICTP Centre in Trieste, Italy, was jointly organised by the FP7 funded projects CHAIN, EU-IndiaGrid2 and EUMEDGRID-Support projects. Climate change is one of the most relevant supported applications in the context of these projects and this event provided an excellent opportunity to review the status and discuss the perspectives and future actions for the cooperation of e-Infrastructure organisations and projects with climatologists.

The conference programme saw the contributions of leading e-Infrastructure initiatives for climate change in Africa, Asia-Pacific, China, Europe, India, Mediterranean Area, Latin America, USA, together with presentations by outstanding scientists in climate research, including the vice-chair of Intergovernmental Panel for Climate Change, Prof Van Ypersele. The need for a worldwide strategy for a global problem was clearly identified and the role of e-Infrastructures and international cooperation in these specific aspects was underlined as a key instrument for achieving the necessary progress in studying and understanding climate change impact and possible mitigation strategies.

The Recommendations of the scientists who attended the conference included:

- Software: Investigation of shared software development projects, on an open source basis in the field of supercomputing and grid computing.

- Grids: broadening the usage of grids and building further links between Indian grid initiatives and the European Grid Initiative (EGI).

- Scientific repositories (i) Access to data repositories and sharing their intrinsically international scope; (ii) access reciprocity; (iii) exchange of views; (iv) cooperation in standards

  for data formats.

Figure 6 Audience at the ICTP Conference in Trieste, May 2011

4.2. Interoperability workshops

3 workshops, one in Belgium at OGF30 (October 2010), one in Delhi (December 2010) and one in Taipei together with CHAIN (March 2011) were organized to deal with specific aspects of interoperability between European and Indian e-Infrastructures. The workshops were excellent opportunities to address and solve concrete issues, as in the case of the Delhi Workshop, where the effective cooperation of project partners solved the issue of the international visibility of GARUDA sites (not accessible from outside India after the transition to high-speed NKN network layer).

4.3. Thematic workshops were an effective showcase of results in EUIG2 specific areas

The thematic Workshops were the showcase for progress achieved in specific areas thanks to the services offered by e-Infrastructures and the opportunity to address issues and to discuss further developments. Two of these workshops were located within international events of high relevance and represented an excellent dissemination opportunity. The Workshop at APAN32 was an excellent example of effective cooperation with relevant projects and initiatives such as TEIN3, NKN and CHAIN.

4.4. Lessons learned

Consortium meetings are important. Despite the distance, four project meetings were held. This resulted in the full involvement of all project partners in their individual work packages as well as the presentation of the project at conferences, tutorials and the project review meeting

Personal engagement: The performance and commitment of each of the beneficiaries was high and this has contributed to the success of the project.

Engagement of policy makers in India is fundamental: relationships between the EU and India partners will survive beyond the life of this project thanks also to the role that project partners played in gaining support for the government of India National Knowledge Network.

When different areas of applications are concerned, the creation of **working groups** (per thematic area) is effective. Targeted communication and dissemination activities on different areas is equally as important.

Different dissemination activities lead to effective outcomes. Diversity of activities, including workshops, publications in newspapers and peer reviewed journals; a well used and updated website presence, and production of other project documentation was extremely useful to ensure interest and awareness across EU & India and to reach across different stakeholders.

5. EU-INDIAGRID2 NETWORKING WITH OTHER INITIATIVES CREATED A BASE FOR FUTURE COOPERATION ACTIVITIES

EU-IndiaGrid2 saw direct collaboration between the European Grid Initiative namely EGI) and GARUDA, the Indian National grid Initiative, in addressing interoperability issues and working to provide a common framework for structuring collaboration between Europe and India in many areas. EU-IndiaGrid2 established very close links with the main relevant initiatives: the Pan European Research Network, GÉANT, the India National Knowledge Network, NKN, the TEIN3 Trans-Eurasia Information Network (TEIN) project. This close cooperation was instrumental in solving concrete problems and supporting the research communities creating the basis for an effective interoperability between European and Indian e-Infrastructures.

The close cooperation with other initiatives and in particular with OGF and the CHAIN project was significant in maximising the impact in common dissemination initiatives and in creating the basis for sustainable interoperability.

The cooperation with PRACE set the basis for a future cooperation on supercomputing initiatives between Europe and India.
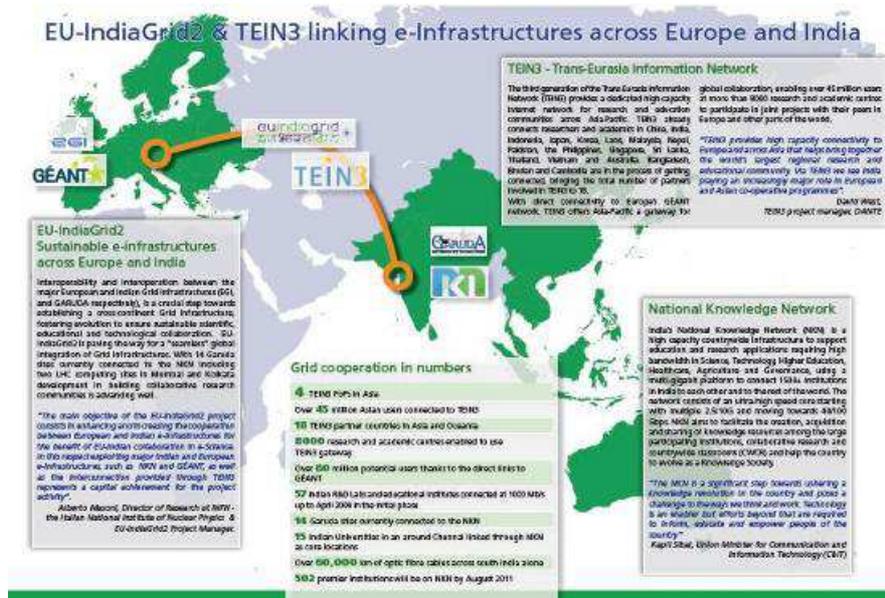

Figure 7 EUIG2-TEIN3 joint flier prepared for the APAN32 conference in Delhi, August 2011.

5.1. Lessons learned

> Establishing **cooperation with other international initiatives** brings value-add: valuable contacts have been established on a policy level thanks to cooperation with international initiatives such as CHAIN, TEIN3, EUMEDGRID-Support, PRACE, and higher visibility, too.

6.   CONCLUSIONS

EU-IndiaGrid2 capitalised on the achievements of its first phase (2006-2008) and, thanks to the support of the European Commission and to the leading role of its partners the project actively contributed to reinforcing f European and India e-Infrastructures maximising their impact in strategic areas for Euro-India research cooperation.

The main milestones in the sustainability process were:

- The establishment of an **Indian Grid Certification Authority**

- The establishment by the Office of Principal Scientific Adviser to India Government of the **multi-gigabit National Knowledge Network Plan (NKN**) and its approval by Government of India with a budget of 1 Billion euro for 10 years.

- The successful deployment and operation of NKN for **over 700 sites**.

- The establishment and the operation of the TEIN3 link interconnecting the Pan European Research Network, GÉANT and the India National Knowledge Network, NKN.

- The successful transition of GARUDA National Grid Initiative to **Operational Phase.**

- The successful support of Euro-India cooperation in strategic research areas including the exploitation of Euro-India e-Infrastructures for the use of main European Laboratories such as the European Laboratory for Particle Physics (CERN) and the European Synchrotron Radiation Facility (ESRF).

The project, contributed directly or with the action of his leading partners, to these fundamental milestones, which represent the pillars of effective, sustainable e-Infrastructures across Europe and India.

The project actions were defined as an example of "best practice" of cooperation between Europe and non-European countries.

As a concluding remark we believe that the key element for project success was due to the commitment of the project partners, combined with their competence and leading role in the most relevant activities for the project.

7. GLOSSARY OF KEY TERMS

APAN	Asia Pacific Advanced Network
CHAIN	Co-ordination and Harmonisation of Advanced e-INfrastructures
e-IRG	e-Infrastructures Reflection Group
GARUDA	The Indian National Grid Initiative
HEP	High Energy Physics
HPC	High Performance Computing
EGI	European grid Initiative
EMI	European Middleware Initiative
GÉANT	The Pan-European Education and Research Network
LHC	The Large Hadron Collider at the European Laboratory for Particle Physics (CERN)
NKN	The National Knowledge Network – The Government of India program for a nation-wide multigigabit network infrastructure http://www.nkn.in/
OGF	Open Grid Forum
PRACE	Partnership for Advanced Computing in Europe
TEIN3	The Trans-Eurasia Information Network
WLCG	Worldwide LHC (Large Hadron Collider) Computing Grid