Indian Initiatives in Grid Computing with respect to Education Perspective

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Abstract: A grid is a collection of distributed computing resources available over a local or wide area network that appears to an end user or application as one large virtual image. Grid computing has serious social consequences and is going revolutionize the world of computing. Education is one domain that can be benefited the most from grid computing. Grid focuses on leveraging technologies and products from academic institutions around the world in the areas of E-learning, Design of front-end portals, Automation of Library and Digital asset Management to promote the sharing and collaboration in the use of technologies, developing Content, defining standards and building best-of-breed pedagogical practices is the new Upcoming trend. Internationally, lots of work is going on in this emerging domain, and India also has joined the bandwagon to contribute to the development in this discipline, this paper aims to present the state-of-the-art of grid computing and attempts to survey India's efforts in developing this upcoming technology. By allowing anyone, anytime to easily access supercomputer level processing power and knowledge resources, grids are underpinning progress in Indian Education.

Keywords—**Grid Computing, E-learning, Web based Education, Tera Grid, Meta Computing Grids.**

I. INTRODUCTION

The World Wide Web is evolved to satisfy the need for information sharing globally; but Grid Computing has evolved to satisfy the need for sharing computer power and data storage globally. Internet user views a unified instance of content via the Web whereas, a grid user essentially sees a single, large virtual computer (IBM). This analogy extends to the evolution pace too. The web evolved slowly but as soon as solid standards and tools appeared there was a tremendous growth. Similarly, though grid computing is presently at a fairly nascent stage, it is seen as a cutting edge technology. Grid computing is an approach to distributed computing that spans not only Locations but also organizations, machine architectures and software boundaries to provide unlimited power, collaboration and information access to everyone connected to a grid (Foster & Kesselman, 2003).

The distributed computing resources available over a local or wide area network appear to an end user or application as one large virtual computing system. All scientific problems require a great number of computer processing cycles. They may also need access to large amounts of data . Such problems may require a variety of heterogeneous resources not available on a single computer. The solution lies with grid computing where the resources of many computers in a network can be applied to a single problem at the same time.

There are a variety of applications that can benefit from the grid infrastructure, including collaborative engineering, data exploration, high throughput computing, and of course distributed supercomputing. Education, particularly distance education & higher education stand to reap significant benefits from grid computing by creating environments that expose students to the various aspects of their discipline. For example, for a science student, rather than using mock or historical data from an observatory, a grid could let students at different geographical locations to actually. Use those facilities and collect their own data.

Learning experiences are made so comfortable and economical by, providing opportunities that otherwise would be impossible or would require travel. Grid computing offers access to particular resources can allow institutions to get in-depth and broader knowledge and scope of their educational programs.

II. LEVERAGING GRID COMPUTING IN EDUCATION: MAJOR INDIAN INITIATIVES
A. GARUDA India: The National Grid Computing Initiative

The Center for Development of Advanced Computing (C-DAC) has been funded by the Department of Information Technology (DIT),India to deploy the nation-wide computational grid 'GARUDA'. Grid Computing has been identified by C-DAC as a major thrust area for the future. The "Proof Of Concept (PoC) phase of National Grid Computing Initiative: Garuda, involving high speed communications fabric; aggregation of geographically distributed resources (computing, data, storage, software

and scientific instruments); architecture, standards, research and technology development; and end-to-end applications development and demonstration has been initiated. GARUDA aims at strengthening and advancing scientific and technological excellence in the area of Grid and Peer-to- Peer technologies.

To achieve its objective, GARUDA brings together a critical mass of well-established researchers, from 45 research laboratories and academic institutions from 17 cities across the country, who have constructed an ambitious program of activities. The 45 research and academic institutions being networked, comprise of 11 C-DAC (Centre for Development of Advanced Computing) centers, ERNET (India's Research and Education Network) and 36 academic and research organizations including all the Indian Institutes of Technology(IITs) and The Indian Institute of Science(IISc.), Bangalore.

The Grid monitoring Centre of Garuda is at Bangalore, India GARUDA will create the foundation for the next generationgrids by addressing long term research issues in the strategic areas of knowledge and data management, programming models, architectures, grid management and monitoring, problem solving environments, tools and grid services. The users will have the option to choose from a fastest response to their task requests or deploying as many available computational nodes to their tasks or simply submitting job requests on a best effort mode of operation.

The fabric component is set-up in partnership with Education and Research Network(ERNET). The GARUDA network is a Layer 2/3 MPLS Virtual Private Network (VPN) connecting select institutions at 10/ 100 Mbps with stringent quality and Service Level Agreements. This Grid is a pre-cursor to the next generation Gigabit speed Wide Area Network nationwide with high performance computing resources and scientific instruments for seamless collaborative research and experiments.

Garuda aims at researching applications characterized by intensive computing and data access requirements like Natural Disaster Management ,Bio-informatics applications and applications of national importance that require aggregation of geographically distributed resources .

CDAC, in association with the Space Applications Centre, which conducts space application research and development in satellite communication and remote sensing, will mine data from a network of sensors deployed over vast disaster prone regions and upload it to Garuda as input to forecast models for disaster management. The initiative will make dynamic sharing of resources and virtual collaborations possible among various research institutions of the country, expectedly, giving a push to Indian education science, engineering and business.

Figure 1: GARUDA Network Connectivity

B. BIOGRID

BIOGRID is a high speed and high bandwidth virtual public network (VPN) established by The Department of Biotechnology, Govt of India. It is envisioned that the BIOGRID will span all the 60+ Bioinformatics centers of the Department of Biotechnology with Gbps bandwidth and 10+ Teraflops of computational power.

Eleven nodes have been established in the first phase, which are actively pursuing bio informatics activities such as human resource development and R&D in bioinformatics besides, dissemination of biotechnology information to researchers in the country.

The nodes are interconnected through 2mbps dedicated leased circuit line at each location and4Mbps Internet bandwidth shared from the central server by al the nodes. The BIOGRID allows exchange of database& software, which have been created /acquired by the individual centres/nodes of BTIS (Biotechnology Information System).

This resource sharing helps in enhancing the value and usefulness of the BTIS. The Department is supporting long-term teaching programs on bioinformatics and BIOGRID will be useful in sharing teaching materials, to deliver lectures through video conferencing-virtual classrooms besides

synergizing research in biotechnology and bioinformatics. In the second and third phase the remaining centres and DBT institutions will be covered under the faster network. The mirror sites of internationally recognized genomic databases such as GDB, Protein Databank (PDB),Plant Genome Data Banks, and Databases of European Bioinformatics institute (EBI) Public domain bioinformatics software packages are also available on the BIOGRID.

The advantage of mirroring these databases in India is to provide unhindered mining of high quality data from well established primary and secondary information sources. Commercial software essential to carry out research & training in bioinformatics will also be made available through BIOGRID. The network will act as a knowledge pathway for discoveries in biotechnology and bioinformatics.

C. KERALA EDUCATION GRID

All students of Kerala, state of India , are given high quality education by the Kerala Education Grid Project which is an initiative undertaken by the Government of Kerala. The Kerala Education Grid provides web based course content as well as various collaboration tools such as message board, discussion boards, shared web space, Chats, asynchronous interaction between students or between students and teachers. The digital content includes streamed videos, technical and scientific journals and publications etc.
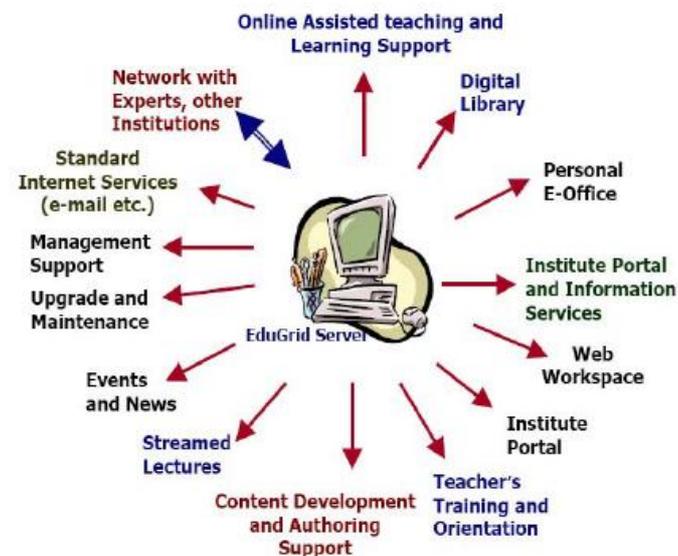
Figure 2: The Kerala Education Grid Education Server and its Services

D. OTHER INDIAN INITIATIVES

There are many other initiatives in India ,to accelerate India's drive to turn its substantial research investment into tangible economic benefits and large

number of other institutions in India have started active programs in Grid computing.

 a) **Sun Microsystems Inc** has named Indian Institute of Information Technology and Management- Kerala (IIITM-K) as a Sun Regional Center of Excellence (COE) for E-Learning. The first regional COE selected in India,IIITM K becomes one of the four universities in the world to be recognized by Sun and the academic community as leading edge researchers in e-learning technologies.

b) IIT Kanpur is deploying Grid Computing hardware and software from Sun India, for its computer centre. The installation will make it the largest AMD Opteron HPTC (High Performance Technical Computing) cluster in the education segment in India. These companies used Grid Computing effectively to achieve considerable cost and productivity advantages.

c) **The efforts of Anna University's** ,**Madras Institute of Technologies (MIT),** who partnered with C-DAC in developing Grid technologies and applications are worth mentioning as they are also making Grids interfaces available in Indian languages. One of their effort was the development of Tamil (a language spoken in the south Indian state of Tamil Nadu) interface for their Grid Market Directory (GMD) user-interface. They also developed a Linux shell UI in Tamil. This is probably the world's first Grid technology with non-English language interface.
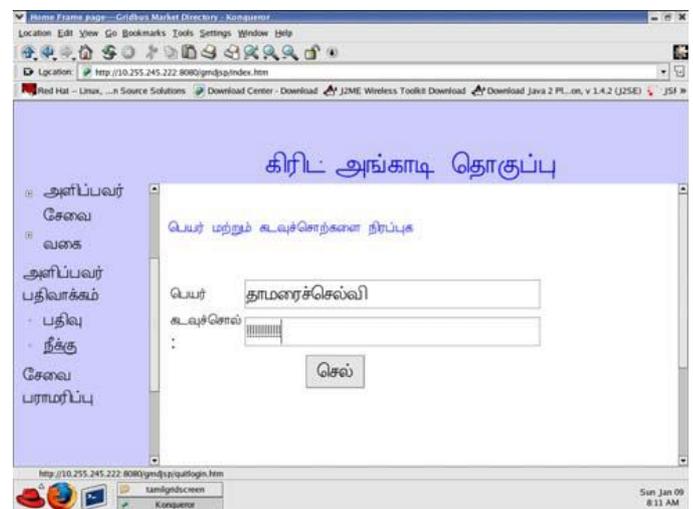
Figure 3 :Tamil(Indian Regional Language)Grid Interface

III E-Learning

In order to meet the present and future requirements of the IT-ITES sector and to capture new opportunities in the electronics hardware industry, there is a need to address the gaps in the availability of skilled and technically trained

human resources . E-Learning mode and the related tools is the suitable choice which provide a platform for enhanced learning, cost effective delivery, flexibility of learning at the convenience of the learner.

Language Technology offer universal access to information and services to the masses in their own language. It is imperative that tools for information processing in local languages are developed and made available for wider proliferation of ICT. This would benefit the people at large and thus pave the way towards 'Digital Unite and Knowledge for All' and bridging the Digital Divide.

Establishment of e-infrastructure for e-Learning is a very important aspect, essential to promote this mode of learning that can also supplement the traditional method of learning. In order to work out a road map to generate human resources for the electronics and ICT industry using ubiquitous learning models. A holistic eco system will be but is for the generation of skilled population which can leverage the use of knowledge effectively for the economic and social development of the country. There is a need to integrate formal and non-formal system of education by introducing the concept of Virtual University or Central University with multiple campuses and blended learning mode.

DOEACC and C-DAC ,as a part of technical skill development initiatives, would be enhanced to generate 10 million skilled manpower by the year 2022 starting from the diploma level right up to doctoral level and in line with the emerging industry/market/society needs. The Central Government also announced scheme for providing financial assistance for setting up of ICT Academy in each State/UT under PPP mode by respective State Governments/UTs along with industry/industry associations.

3.1 Distributed and Shared Infrastructure for E-Learning

Technology supported learning is a very broad area covering a number of different realities, depending on the target audience (schools, universities, vocational training, life-long learners), the pedagogical model and the socio-economical context.

Following are some of the **key issues** where ICT is expected to play an essential role:
- Distance learning
- Collaborative learning (e.g. problem solving by teams of learners)
- Use of virtual or mixed reality for learning in complex training environments
- Sharing of educational material, using metadata and raising complex IPR issues
- Personalized learning (learning path determined by the needs and background of the learner)
- On-the job learning (integration of training and work)
- Learner assessment

3.2 Motivation for GRID in E-learning

Areas of E-learning suitable for GRID-based applications. Some areas of e-learning can only really take off if a GRID type infrastructure is available.

- Advanced distance learning, implementing the concept of virtual classroom, where teachers and learners are geographically dispersed and where the use of interactive multimedia objects is required.
- Collaborative learning, which requires advanced communication facilities (e.g. video-conferencing) and application sharing facilities.
- The implementation of the concept of e-campus, where universities not only share course material but also research and computing facilities is only possible with a GRID infrastructure.
- The use of virtual and mixed reality simulations in a number of complex training areas (e.g. training of surgeons, training of maintenance staff of complex equipment, training of mechatronic engineers).

3.3 Contribution of e-learning applications to GRID technology development

The GRID technology is not only an enabler of e-learning applications, it could also benefit from the special requirements imposed by these applications on the GRID:

- Advanced multicasting facilities
- High-class visualisation environments
- Reliability and availability of the infrastructure
- e-learning specific middleware (e.g. for content representation, specific IPR issues).

3.3.1 Strengths

Europe's experience in distance learning and pedagogical innovation
- EU's political commitment through the e-Learning action plan
- Long history of Cupertino among Universities
- Strong VR simulation expertise

3.3.2 Weaknesses

- Fragmented market
- No large industrial players
- Significant infrastructure costs
- Only small part of e-learning issues addressed

3.3.3 Opportunities

Possibility to implement new pedagogical paradigms, e.g. Distributed collaborative learning
Challenging technological problems to be solved:

- multicasting
- virtual/mixed reality environments
- high-quality visualization environments
- Demanding end-user needs:
- reliability/availability of the infrastructure
- user-friendly interfaces

3.3.4 Threats

- Too high infrastructure costs
- Complex application development required
- Technology not reliable enough
- Resistance to change

C-DAC and IIT Karaghpur through DIT funded project took collaborative initiative to harness GARUDA Grid Computing Infrastructure to carryout implementation of e-learning solution and to address research aspects of E-learning over Grid Environment. Also they set up Quality of Service (QoS)) test bed project to carry out research in setting up E-Learning platform and experiments of QoS for E-learning.

3.3.5 E-Learning Tasks lists:

The following is the list of E-Learning tasks framed by C-DAC and IIT Karaghpur

1. Content aggregation and Content hosting
2. Accessibility of E-learning content from Garuda nodes
3. High-End E-learning environment setup
4. Enabling Access-grid mechanisms.

3.3.6 Outcome: Demonstration of E-Learning applications over the Garuda Grid for e-learning related activity amongst partner organizations (such as JNU Delhi, SGPGI Lucknow and RCC Trivandrum, C-DAC and IIT), Enhanced solutions and publications.

3.4 Educational applications

Always there is a need for the educational sector to increase the availability of great number of sources of valuable contents, and for which incremental creation and refinement of contents is essential. This has lead to proposals for large-scale peer-to-peer educational resources and "educational Napsters". The affinity of this domain with open source software is essential, as the limit between software and contents is often very thin in educational applications. The driving forces (including in technology development) are the teachers themselves, which raises issues of how to be able the related constituency can organise itself.

3.5 E-Learning opportunities and skill development

a. Most e-Learning courses being incubated by Universities and institutions like C-DAC are not tailored to the needs of rural community, who faces challenges due to language, awareness as well as absence of such learning opportunities tailored to their needs. AICTE and Ministry of Human Resources Development should actively focus on content creation and structuring courses to address the aspirations of rural youth. As a channel of outreach to such communities, CSC network could be used. However, the capacity of CSCs will need adequate enhancement – by way of both sufficient connectivity/bandwidth availability at the Panchayat level and training/availability of trainers – to undertake such course/content dissemination.

b. It is also important to enhance and strengthen the infrastructure and capacity of existing institutions (e.g. schools) to undertake e-learning activities. Efforts would be made to ensure that every school going child has access to Internet. A Portal may also be developed along with awareness and communication campaign in respect of such content and delivery channels.

c. Besides content and course creation, it is also important to encourage development and distribution of innovative and appropriate low cost devices (e.g. low cost ipads) which would enable improvement in e-Literacy and empowerment of citizens/students across the country including rural areas. Government may provide funding support for such innovation.

d. The National Skill Development Corporation (NSDC) is to skill/upskill 150 million people in India including persons from rural areas by the year 2022,mainly by fostering private sector initiatives in skill development programmes and providing viability gap funding.NSDC would cover skills from the organized as well as from the un-organized sector. However, it is important to identify and develop databank of the skill gaps taking into account the trends in demand, both in the organized and un-organized sectors, through standardized survey formats wherein ICT and CSCs could be very effective; and modular employable skills are identified for the purposes of content creation and for delivery through e-learning mode.

e. Basic IT training may be targeted to at least one person per family across the country. At least 50% of the families may be targeted for such training in the XII Plan period. In particular, DOEACC as a training agency may launch IT based skill development initiatives aimed at hilly States and difficult terrains of Jammu & Kashmir, Uttarakhand and north eastern states.

3.6 Need for E-Learning

1. Skilled manpower development programmes need to be initiated in the frontier areas based on the current technology requirements of the Industry.
2. Phase II for the Information Security Education and Awareness (ISEA) project in an integrated fashion and also to institutionalize the mechanism.
3. It is essential to create capacity building infrastructure for generation of skilled human resource, which effectively harnesses the benefits arising out of our demographic advantage.
4. Industries and Educational institutions has to initiate more R&D projects in the area of e-learning tools, technologies and pedagogy.
5. The concept of Virtual University or Central University with multiple campuses are need to be developed for integrating formal and non-formal system of education.
6. An integrated and holistic project for the development of North eastern region through capacity building in the IECT sectors need to be taken up.
7. As a part of skill development initiatives, the capacities of DOEACC and CDAC would be enhanced to generate 10 million skilled manpower by the year 2022 starting from the diploma level right up to doctoral level and in line with the emerging industry/market/society needs. .
8. There is a need to build HR centric applications such as Virtual Labs, country wide Virtual Classrooms, etc.
9. Need to bring in an 'IT Mass Literacy' movement for inclusion of all the citizens of India (especially the rural and the far flung areas) in the IT revolution. There is a need to create the benchmarks for functional literacy for various segments, design course-ware in multi-lingual format for multi-modal delivery.
10. Continuation of SMDP in VLSI Design and related software in XII plan with enhanced scope and coverage.
11. There is a need to launch an integrated and holistic capacity building programme for Electronics Product Design and Manufacturing Technology covering entire layer of human resources development (including faculty development) starting from certificate level up to PG/Doctoral level covering the areas of right from manufacturing/production floor up to product Design and Development as well as applied research.
12. Create a pool of skilled labour for the semiconductor design industry.
13. Technology Development Projects in mission mode to continue for development of language technologies, which is a complex inter-disciplinary area of research.
14. A National Localization Research & Resource Centre (NLRRC) to be set up to focus on the development of software tools, standards, linguistic resources, localization of e-governance services, creating awareness and providing training and consultancy.
15. Technologies and components for voice browser in Indian languages would be developed.
16. Mobile phone is emerging as an access device, and hence initiatives would be taken for enabling mobile and wireless devices for Indian languages.
17. Initiate key programmes and projects in specific areas of internet technologies and proliferation.
18. Infrastructure initiatives with special focus on sectors like: Education, Health, and Agriculture
19. Initiatives for Creation of National Cloud Computing Infrastructure, capacity for its regulation, development of open standards to address interpretability issues.
20. Exploring the possibility of establishment of National Productivity Network (NPN) to facilitate use of IECT for enhancement of productivity.
21. Initiatives for creation of sideway network, so that every school going child to have access.
22. Creation of unmediated environments / ambiance (like Wikis) for content development through participation, and the user will make contribution themselves.

IV . Leverage Technology for Education

A series of productivity challenges exist in the typical model of teaching and learning in the primary and secondary level of education. Technology enabled learning can overcome current challenges and significantly improve productivity. Suggested technology initiatives below can address **key challenges.**

➢ Integrated IT solutions for in-classrooms instruction
➢ Efficient document on-boarding and platform hosting services for teachers/students.
➢ Innovative technology enabled 'model schools'.
➢ Technology enabled testing and assessment solutions
➢ Technology enabled teacher training
➢ State-run online/ virtual schools for mainstream and vocational education

4.1 Stakeholders involved

- DIT(HRD)
- Ministry of Human Resource Development

4.2 Implementation

Funding support from the government is needed for procuring equipments, initially to follow BOOT model for operational purposes. To enhance Technology adoption for the following:

- Innovative technology enabled 'model' schools - Managed by the government operationally; PPP with network and infrastructure players ; content prescribed by the government.
- Technology enabled testing and assessment solutions – Dedicated funding sanction centrally for CBSE and state level for State boards; content prescribed by the government
- Technology enabled teacher training - PPP with training institutes; Content decided by government in partnership with private vendors.

V.FUTURE TRENDS

Larry Smarr in (Foster 1999) observes that the effects of computational grids are going to change the world so quickly that mankind will struggle to react and change in the face of the challenges and issues they present.While challenges still lie in the path of large-scale adoption of Grid Computing on account of lack of standards, immature solutions, and lack of skills and experience at the vendor level, low awareness among users and the cost of initial investment in equipment and software, the technology is expected to proliferate by 2020. The importance of international cooperation in grid technologies to benefit collaborative team science is now widely recognized and accepted.

The widely available grids for scientific research are national in nature (e.g., TeraGrid in the U.S.,Garuda in India), and their software applications and middleware are tailored to run on the specific country's infrastructure.

In future, more work is expected to be done for the interconnection of the national grids.

VI.CONCLUSION

A great number of scientific and commercial applications all over the world have started harnessing the power of grid computing and India is not far behind. The Govt. of India and many key Indian companies are making efforts to move it beyond scientific applications into mainstream IT infrastructure. The efforts at international level , national level and even state level projects, promise a bright future for Grids.

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