CSI COMMUNICATIONS

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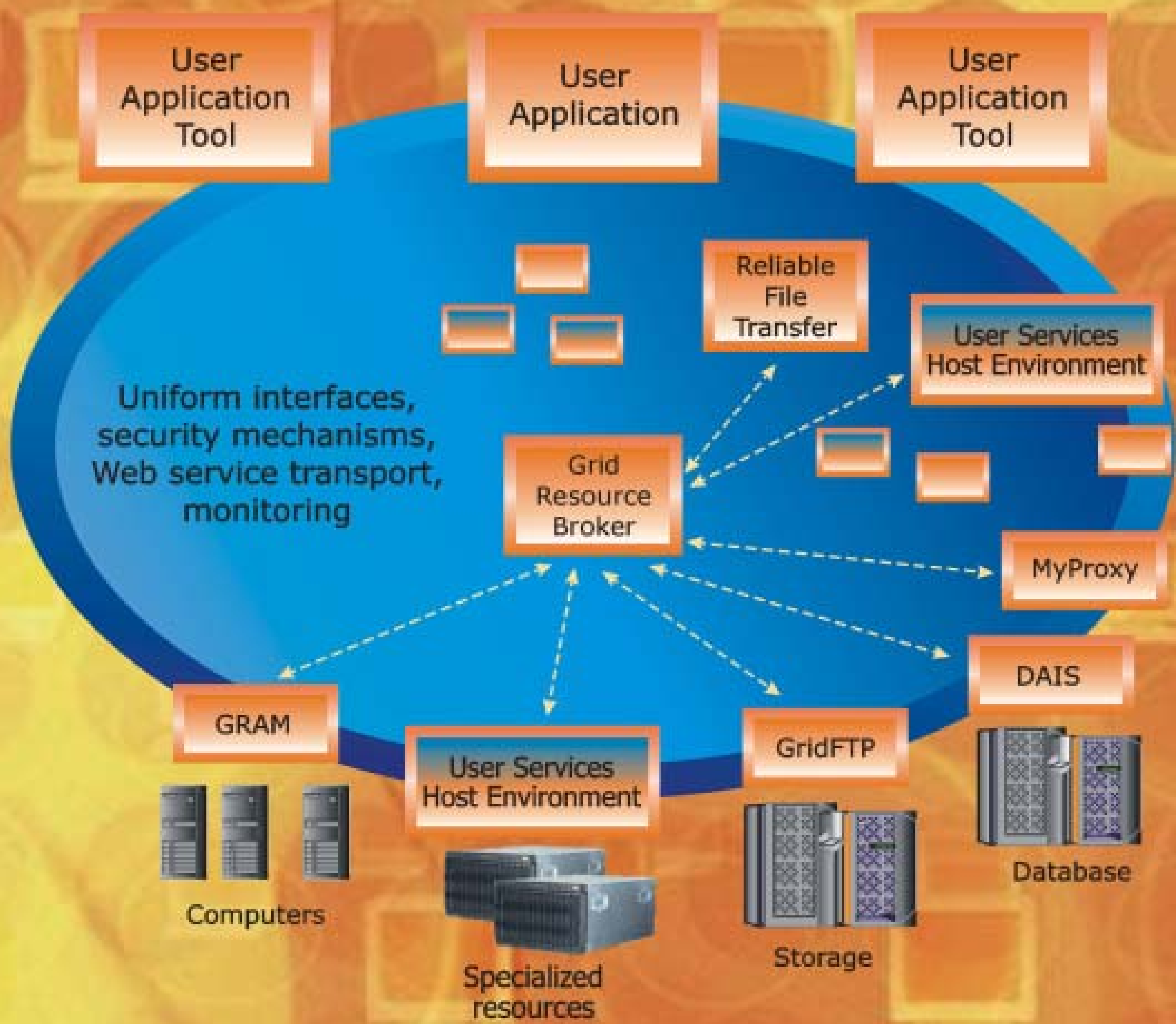
Grid Computing



CSI ELECTIONS 2006-2007 / 2006-2008

We thank you for electing us to work together on the CSI Nominations Committee 2005-06. We believe the Nominations Committee has a significant role to play in ensuring that we build the CSI of our dreams at this crucial juncture. Some of the areas we will focus on are:

- Attracting the best talent to participate in building CSI
- Improving the percentag e of members voting
- Introducing Internet Balloting & use of technology in the Election process
- Conducting the elections on time in a free & fair manner
- Supporting the Chapter Nominations Committee in conducting elections

All election-related notices will be published on the CSI Homepage www.csi-india.org. The date of publishing the election related notices on the CSI Homepage www.csi-india.org will be considered as the date of publication. The election results have to be announced not later than December 31, 2005. The proposed dates for various stages of the above elections are:

Monday, August 1, 2005 Announcement on CSI homepage inviting Nominations. Also published in the August & September 2005 issues of CSI Communications.

Monday, September 26, 2005	Last date for receipt of Nominations
Friday, September 30, 2005	Communication of slate by NC to ExecCom and Call for Petitions. Slate to be published on CSI homepage & in CSI Communications Oct 2005 issue.
Friday, October 21, 2005	Last date for receipt of petitions
Friday, October 28, 2005	Last date for Withdrawal of candidature
Wed, December 21, 2005	Last date for receipt of Ballots (both Internet & postal)

These dates can be changed by suitable announcements on the CSI Homepage www.csi-india.org

The internet ballots we plan to introduce will be an hybrid solution allowing for the following situations:

- Voting by Members with Both internet access and email-id
- Voting by Members with internet access But No email-id
- Voting by members by paper ballots

We would urge all members who have email-ids to update the same at the earliest with the CSI Headquarters. This will allow the member to experience the complete benefits of internet balloting. We invite your suggestions (email: csi@sampoorna.com). We look forward to your support to make a success of Internet Balloting and helping CSI take a leadership position in showcasing the use of IT for Elections.

Nominations Committee 2005-06, CSI

Satish Doshi (Chairman)

M D Agrawal (Member)

Dr Nirmal Jain (Member)

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Special Theme Issue on Grid Computing

DEPARTMENTS

CSI TOPICS

Community Talk

Community Talk

Numerous initiatives and architectures to permit computing using objects across a network of connected systems have been developed under the broad aegis of **'Distributed Computing'.**

A flavor of distributed computing where you can harness idle CPU cycles and storage space of tens, hundreds, or thousands of networked systems to work together on a particularly processing-intensive problem is the **foundation** for a current model of computation called 'Grid Computing'. There is lot more to it aver the specialists in Grid Computing. Advances in avoidance of bandwidth bottlenecks, vastly improved security, better management, and emerging standards are fuelling the deployment of this model. Compelling applications warranting the use of this model are also gradually emerging.

Our Guest Editor, Dr. Rajkumar Buyya, is an internationally renowned professional actively fostering the growth of Grid Computing. He has been kind enough to provide a very valuable collection of articles that would enable the readers to harness the potential of the tools and techniques discussed. 'Grid Computing' is presently an elective offered to the Undergraduate and Postgraduate students in many leading academic institutions. This issue would serve as a valuable reference to the academia.

To my mind, Distributed Computing and Grid Computing are two similar trends moving in tandem. There is a considerable degree of overlap. Grid Computing facilitates the **'Poor Man's Supercomputer'.** The **SETI@Home** {**S**earch for **E**xtra **T**errestrial **I**ntelligence - SETI} project amply demonstrates this aspect of Grid Computing. What is Intelligence ? is one of the Big Questions asked by Science. There is no clear answer as yet. As in many cases, affordable computing infrastructure is just the beginning the real tough challenges in this project are ahead.

Not all applications benefit from this model of computing. Some possible applications are:

- A query search against a huge database that can be split across lots of desktops
- Complex modeling and simulation techniques that increase the accuracy of results. Car crash simulations is an example.
- Exhaustive search techniques that require searching through a huge number of results. Drug screening is an example.
- Life Sciences
- Complex financial modeling, weather forecasting, and geophysical exploration

SDKs and APIs are currently the popular approaches to facilitate porting of the applications. Working out standards for safe, secure and reliable communications among platforms is part of the typical chaos occurring in this relatively new technology. The **Global Grid Forum** is a collection of around 200 companies looking to devise grid computing standards.

With best regards,

Gopal T V

Chief Editor

gopal@annauniv.edu

From the President's Desk

From : lalit.sawhney@gmail.com
Subject : President's Desk.
Date : 5th July, 2005.

Dear Members,

Let me start off by thanking you for giving me an opportunity to serve the society at this important juncture. The IT industry is growing by leaps and bounds, occupies a leadership position in the world today, and has developed great confidence in itself. While we have a million IT professionals in the country today, only a few of them are members of our society. If we can gear ourselves to meet the professional needs of our members – from the IT industry, the academicians and researchers, the student members, the user community, the CIOs, CTOs, developers, IT department staff, we have the opportunity to grow to ten times our size.

Our members need to upgrade their skills and keep up with rapid technological change. The profession is growing in many new emerging areas of IT applications – Bio-informatics, IT Enabled Services, Embedded Systems, Telecommunications, E-Governance, etc., etc. As the premier body of IT users, we need to help our members realise life-long careers in this exciting profession. And, after addressing the needs of our members, we need to take on the huge task of promoting IT for national development, for helping define the national IT agenda, developing affordable computing hardware and software, setting up the IT infrastructure, promoting effective implementation of this technology in our businesses, financial institutions, government, in public and private sector, in schools, colleges, for exports and use at home.

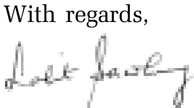
I have just got back from New Delhi where the new Executive Committee met for its meeting, to discuss the above tasks. I am happy to report that we have a very happy and cohesive team this year, and except for two members who could not make it, the entire Execom was there in full strength. The Divisional Chairmen, Regional Vice Presidents and the Office Bearers discussed their plans for the year and the Honorary Treasurer shared details of the last year's expenses. We have also tried to broad base our statutory committees by inviting many senior members to join. We discussed plans for conferences, formation of Special Interest Groups, spent time on proposals for promoting research and spent some time thinking about brand building for CSI. We hope to finalise all our plans and budgets for 2005-06 by the end of this month, and start sharing these plans with you all through CSI Communications, starting next month. You will soon be able to pay your annual membership fees and cast your votes electronically. We will strengthen our secretariat to improve our membership services, our publications, the web site and catch up with all our administrative tasks. We also discussed the plans for CSI 2005 to be held at Hyderabad on 9-12 November 2005 and the host chapter will share the proposed programme and the arrangements with you next month.

The Awards committee for National E-Governance Awards has just completed the selections and is getting ready to announce the results and distribute the Awards. They had almost a hundred entries and the selection panel had a tough time choosing from the rich variety of projects, which were entered for the Awards. Ten years ago, I was part of the CSI IT Policy Committee, which had recommended Application awards to showcase and promote good usage of IT in the country; well before such awards became common. Last month some of us had gone to meet the Inspector General and Commissioner, Registration and Stamps in Hyderabad – you will be happy to know that he proudly showed us the CSI E-Governance Award won by his department last year. Obviously we need to take up the rest of the CSI Awards and publicise the award winning entries to highlight pioneering work being done all around us.

I would also like to welcome all the new Chapter Managing Committees, which are taking office and wish you all a very eventful and professionally rewarding CSI year.

I would like to invite members' views on what they expect from CSI, what you see right with the society, and more important, what improvements you would like to see in our membership services, conferences and seminars, training courses and tutorials, educational and certification programs, publications, the web site and other facilities. I look forward to hearing from you,

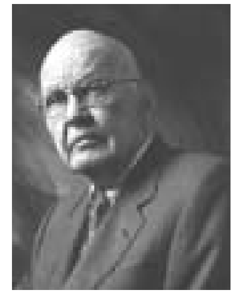
With regards,



Lalit Sawhney

Jack Kilby – A Legend Passes Away

A Tribute to the Inventor of the Integrated Chip



"I think I thought it would be important for electronics as we knew it then, but that was a much simpler business and electronics was mostly radio and television and the first computers. What we did not appreciate was how much the lower costs would expand the field of electronics into completely different applications that I don't know that anyone had thought of at that time".

- Jack Kilby on the Integrated Circuit

There are few men whose insights and professional accomplishments have changed the world. Jack Kilby is one of these men. His invention of the monolithic integrated circuit - the microchip - some 45 years ago at Texas Instruments (TI) laid the conceptual and technical foundation for the entire field of modern microelectronics. It was this breakthrough that made possible the sophisticated high-speed computers and large-capacity semiconductor memories of today's information age.

Mr. Kilby grew up in Great Bend, Kansas. With B.S. and M.S. degrees in electrical engineering from the Universities of Illinois and Wisconsin respectively, he began his career in 1947 with the Centralab Division of Globe Union Inc. in Milwaukee, developing ceramic-base, silk-screen circuits for consumer electronic products.

In 1958, he joined TI in Dallas. During the summer of that year working with borrowed and improvised equipment, he conceived and built the first electronic circuit in which all of the components, both active and passive, were fabricated in a single piece of semiconductor material half the size of a paper clip. The successful laboratory demonstration of that first simple microchip on September 12, 1958, made history.

***Courtesy** M/s Texas Instruments Incorporated*
[http://www.ti.com/corp/docs/kilbyctr/jackstclair.shtml]

Jack Kilby went on to pioneer military, industrial, and commercial applications of microchip technology. He headed teams that built both the first military system and the first computer incorporating integrated circuits. He later co-invented both the hand-held calculator and the thermal printer that was used in portable data terminals.

In 1970, he took a leave of absence from TI to work as an independent inventor. He explored, among other subjects, the use of silicon technology for generating electrical power from sunlight. From 1978 to 1984, he held the position of Distinguished Professor of Electrical Engineering at Texas A&M University.

Mr. Kilby officially retired from TI in the 1980s, but he has maintained a significant involvement with the company that continues to this day.

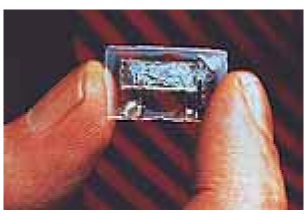
Jack Kilby is the recipient of two of the nation's most prestigious honors in science and engineering. In 1970, in a White House ceremony, he received the National Medal of Science. In 1982, he was inducted into the National Inventors Hall of Fame, taking his place alongside Henry Ford, Thomas Edison, and the Wright Brothers in the annals of American innovation.

Mr. Kilby holds over 60 U.S. patents. He is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) and a member of the National Academy of Engineering (NAE). He has been awarded the Franklin

Institute's Stuart Ballantine Medal, the NAE's Vladimir Zworykin Award, the American Society of Mechanical Engineers' Holley Medal, the IEEE's Medal of Honor, the Charles Stark Draper Prize administered by the NAE, the Cledo Brunetti Award, and the David Sarnoff Award. On the 30th anniversary of the invention of the integrated circuit, the Governor of Texas dedicated an official Texas historical marker near the site of the TI laboratory where Mr. Kilby did his work.

In 2000, Jack Kilby was awarded the Nobel Prize in Physics for his part in the invention of the integrated circuit.

From Jack Kilby's first simple circuit has grown a worldwide integrated circuit market whose sales in 2004 totaled $179 billion. These components supported a 2004 worldwide electronic end-equipment market of $1,186 billion. Such is the power of one idea to change the world.



The Chip that Jack Built Changed the World

It was a relatively simple device that Jack Kilby showed to a handful of co-workers gathered in TI's semiconductor lab more than 40 years ago — only a transistor and other components on a slice of germanium. Little did this group of onlookers know, but Kilby's invention, 7/16-by-1/16-inches in size and called an integrated circuit, was about to revolutionize the electronics industry.

The Answer to a Problem

It was in a relatively deserted laboratory at TI's brand new Semiconductor Building where Jack Kilby first hit on the idea of the integrated circuit. In July 1958, when most employees left for the traditional two-week vacation period, Kilby — as a new employee with no vacation — stayed to man the shop.

What caused Kilby to think along the lines that eventually resulted in the integrated circuit? Like many inventors, he set out to solve a problem. In this case, the problem was called "the tyranny of numbers."

For almost 50 years after the turn of the 20th century, the electronics industry had been dominated by vacuum tube technology. But vacuum tubes had inherent limitations. They were fragile, bulky, unreliable, power hungry, and produced considerable heat.

It wasn't until 1947, with the invention of the transistor by Bell Telephone Laboratories, that the vacuum tube problem was solved. Transistors were miniscule in comparison, more reliable, longer lasting, produced less heat, and consumed less power. The transistor stimulated engineers to design ever more complex electronic circuits and equipment containing hundreds or thousands of discrete components such as transistors, diodes, rectifiers and capacitors. But the problem was that these components still had to be interconnected to form electronic circuits, and hand-soldering thousands of components to thousands of bits of wire was expensive and time-consuming. It was also unreliable; every soldered joint was a potential source of trouble. The challenge was to find cost-effective, reliable ways of producing these components and interconnecting them.

One stab at a solution was the Micro-Module program, sponsored by the U.S. Army Signal Corps. The idea was to make all the components a uniform size and shape, with the wiring built into the components. The modules then could be snapped together to make circuits, eliminating the need for wiring the connections.

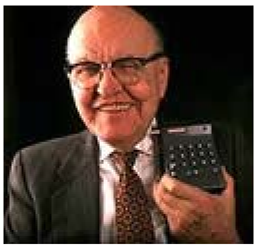
Enter Kilby

TI was working on the Micro-Module program when Kilby joined the company in 1958. Because of his work with Centralab in Milwaukee, Kilby was familiar with the "tyranny of numbers" problem facing the industry. But he didn't think the Micro-Module was the answer — it didn't address the basic problem of large quantities of components in elaborate circuits.

So Kilby began searching for an alternative, and in the process decided the only thing a semiconductor house could make cost effectively was a semiconductor. "Further thought led me to the conclusion that semiconductors were all that were really required — that resistors and capacitors [passive devices], in particular, could be made from the same material as the active devices [transistors]. I also realized that, since all of the components could be made of a single material, they could also be made in situ interconnected to form a complete circuit," Kilby wrote in a 1976 article titled "Invention of the IC."

Kilby began to write down and sketch out his ideas in July of 1958. By September, he was ready to demonstrate a working integrated circuit built on a piece of semiconductor material. Several executives, including former TI Chairman Mark Shepherd, gathered for the event on September 12, 1958. What they saw was a sliver of germanium, with protruding wires, glued to a glass slide. It was a rough device, but when Kilby pressed the switch, an unending sine curve undulated across the oscilloscope screen. His invention worked — he had solved the problem.

Early Successes



Kilby had made a big breakthrough. But while the U.S. Air Force showed some interest in TI's integrated circuit, industry reacted skeptically. Indeed the IC and its relative merits "provided much of the entertainment at major technical meetings over the next few years," Kilby wrote.

The integrated circuit first won a place in the military market through programs such as the first computer using silicon chips for the Air Force in 1961 and the Minuteman Missile in 1962. Recognizing the need for a "demonstration product" to speed widespread use of the IC, Patrick E. Haggerty, former TI chairman, challenged Kilby to design a calculator as powerful as the large, electro-mechanical desktop models of the day, but small enough to fit in a coat pocket. The resulting electronic hand-held calculator, of which Kilby is a co-inventor, successfully commercialized the integrated circuit.

Impact

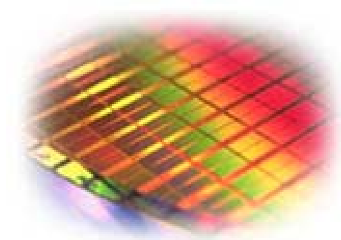
The impact of Kilby's tiny chip has been far-reaching. Many of the electronics products of today could not have been developed without it. The chip virtually created the modern computer industry, transforming yesterday's room-size machines into today's array of mainframes, minicomputers and personal computers.

The chip restructured communications, fostering a host of new ways for instant exchanges of information between people, businesses and nations.

- Without the chip, man could not explore space or fly to the moon.
- The chip helps the deaf to hear and is the heartbeat of a myriad of medical diagnostic machines.
- The chip has also touched education, transportation, manufacturing and entertainment.

For Texas Instruments, the integrated circuit has played a pivotal role. Over the years, the company has produced billions of chips. But the integrated circuit has done more than help grow TI. It has enabled an entire industry to grow. Since 1961, the worldwide electronics market has grown from $29 billion to nearly $1,150 billion. Projections indicate that it will become the world's single largest industry.

This growth will depend on the continued development of newer and better technologies — like those being developed at TI's new research and development center in Dallas. The $150 million Kilby Center, named in the IC inventor's honor, is the world's most advanced research center for silicon manufacturing.



Toward the Future

With continuing advances in semiconductors, you can look forward to more new amazing encounters with electronic equipment. Imagine calling your day care center to check on your child, and seeing her smiling face in the screen on your cell phone. Imaging turning on the oven from your car phone as you pull out of the parking lot at the end of the day. When you get home, dinner will be nearly done. Imagine setting your car on autopilot, and looking over notes for your next day's meeting on your commute home. Imagine you want to see a movie. You order it from the web, and within a matter of seconds it's ready to view on your television at home.

It sounds like the stuff of science fiction, but new breakthroughs are only a short stride away, with the help of technologies being developed at the Kilby Center at Texas Instruments.

Special Thanks are due to Dr C. P. Ravikumar, Texas Instruments, Bangalore and Secretary VLSI Society of India [Email: ravikumar@vlsi-india.net] for helping us on including this tribute.

Grid Computing: Making the Global Cyberinfrastructure for eScience a Reality

Rajkumar Buyya[1]

"Gartner Research recently unveiled its IT Circa 2008, predictions for computing in the year 2008, eliciting a number of opinions from IT-savvy readers and experts. Gartner predicted that increased network capacity will allow businesses and consumers to draw their computing resources from Grids instead of from local devices. For that to happen, however, such a computing ecosystem would require massive improvements to still-nascent grid-computing software, as well as IT systems with self-healing functions."[2]

Scientific discoveries and business decisions in the present day are increasingly made through collaboration largely due to non-availability of all required resources and expertise within a single organization. Also, it is economically not viable for a single organization to own all required resources and expertise especially when they are expensive to own, maintain, and their service is required once in a while.

Scientific disciplines such as High Energy Physics (HEP) investigate matter at the very smallest scales. Probing this frontier requires accelerators of great complexity, typically beyond the means of any single country. Since experiments in HEP are large and technically sophisticated, they generally involve international collaboration between many countries and institutions over very long time scales and distance. They need ability to share various types of experimental resources such as scientific instruments, computational devices, and storage and carry out analysis and interpretation of data generated by experiments in a collaborative manner. Such scientific endeavor that is carried out through collaborations and resource sharing across organizational boundaries is popularly termed as *e-Science*.

Grid Computing, which derived its name and inspiration from electric power grids, enables pervasive access and cooperative sharing, exchange, selection, and aggregation of geographically distributed heterogeneous resources similar to power grid providing access to electricity irrespective of its location or type of power generators. Accordingly, it has been recognised as an enabler for construction of next generation Cyberinfrastructure required for e-Science. Due to its potential to make impact on the 21^{st} century as much as electric power grid did on 20^{th} century, Grid computing has been hailed as the next revolution after the mighty Internet and the Web.

Grid computing follows service-oriented architecture and provides hardware and software services and infrastructure for secure and uniform access to heterogeneous resources and enables formation and management of virtual organizations. It also supports application and services composition, workflow expression, scheduling, and execution management and service-level agreements based allocation of resources.

Different types of Grid computing platforms supporting resource pooling or sharing at various levels and scales have been developed. These include systems (1) for harnessing idle or unused CPU cycles from desktop computers in the network that can scale from an enterprise to a global level (e.g., SETI@Home, Condor, and Alchemi), (2) for federation and sharing of data resources across multiple organizations (e.g., SRB and OGSA-DAI), (3) that allow sharing of computational and data resources, replication, and collaborative analysis of distributed datasets (e.g., Globus, EU DataGrid, Gridbus), (4) that support market-based allocation and management of grid resources and turn grid services into utilities that can be sold or leased as IT utility (e.g., Gridbus), and (5) that enable the sharing of computational, databases, and application servers (e.g., Oracle 10g).

[1] *Director, GRIDS Lab, University of Melbourne, Australia.*

[2] *http://www.acm.org/technews/articles/2002-4/1023w.html#item7*

In this theme issue of CSI Communications, I have included four feature articles co-authored by researchers from Australia, India, Singapore, and USA. They reflect neither the scope nor the depth of growing body of knowledge in Grid computing, but aim at covering a range of issues involved in building grids for scientific and business applications: infrastructure requirements, technological challenges, resource and data management, integration of sensor networks into grids, and commercialization.

The first article, co-authored by myself and Srikumar Venugopal, introduces Grid computing paradigm followed by a discussion on two Grid technologies and their capabilities. It starts off with motivations for grid computing and then identifies key challenges in building Grid infrastructure for e-Science applications. It briefly presents major Grid initiatives around the world and then discusses components of Grid computing environments and operational steps from user's perspective. It discusses Globus and Gridbus technologies along with services and capabilities they provide for building e-Science applications.

The second article discusses issues involved in sharing data across different organizations and how Data Grids deal with them. Dr. Elizabeth Sherly from Indian Institute of Information Technology and Management,

Trivandrum presents the use of Data Grid technologies in developing Kerala Education Grid.

Grid computing allows integrated use and management of not only distributed computational and data resources, but also Sensors networks that assist in monitoring environments. The third article co-authored by Prof. Chen-Khong Tham from the National University of Singapore presents various aspects involved in integration of sensor networks into global Grid computing environments.

The success of Grid computing lies in its uptake by industries leading to its usage in solving business problems. The fourth and final article by Dr. Wolfgang Gentzsch who co-founded one of the first Grid companies, called Gridware that was later brought by Sun Microsystems, discusses how Grid computing is evolving from research to commercial environments, various issues involved in industrializing Grid computing, and identifies various benefits of Grid computing. He also presents various initiatives in Grid computing pursued by the five leading IT companies: HP, IBM, Microsoft, Oracle, and Sun.

Here are pointers to some Web-based resources on Grid Computing:

1. Grid Computing Information Centre: http://www.gridcomputing.com/
2. IEEE DSOnline on Grid Computing: http://dsonline.computer.org/gc
3. Global Grid Forum: http://www.ggf.org/
4. Grid Computing Course at Melbourne: http://www.cs.mu.oz.au/678/
5. Master of Engineering in Distributed Computing Degree: http://www.cs.mu.oz.au/courses/mbc/medc.html
6. The Globus Project: http://www.globus.org
7. The Gridbus Project: http://www.gridbus.org

I would like to thank Dr. T. V. Gopal and the Computer Society of India for providing me an opportunity to edit this special issue. I hope you will enjoy reading it and be inspired to pursue the field of Grid computing to explore its potential.

If you have any specific comments on this special issue or Grid computing field in general, please feel free to contact me. It will be my pleasure to exchange thoughts and ideas with you!

Rajkumar Buyya (Guest Editor)
June 24, 2005, Melbourne, Australia.
Email: raj@csse.unimelb.edu.au

Dr. Rajkumar Buyya is a Senior Lecturer and the Storage Tek Fellow of Grid Computing in the Department of Computer Science and Software Engineering at the University of Melbourne, Australia. He is also serving as the Director of the Grid Computing and Distributed Systems Laboratory. He has authored/co-authored over 100 papers and technical documents that include three books—Microprocessor x86 Programming, Mastering C++, and Design of PARAS Microkernel. He received B.E, M.E, and Ph.D. degrees from Mysore, Bangalore, and Monash Universities respectively. He was awarded Dharma Ratnakara Memorial Trust Gold Medal for academic excellence in Mysore University. He is currently serving as Co-Chair of the IEEE Technical Committee on Scalable Computing and Associate Editor of the Journal of Future Generation Computing Systems, Elsevier Press, Holland. For further information on Dr. Buyya, please browse: http://www.buyya.com

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A Gentle Introduction to Grid Computing and Technologies

Rajkumar Buyya and Srikumar Venugopal

Grid is an infrastructure that involves the integrated and collaborative use of computers, networks, databases and scientific instruments owned and managed by multiple organizations. Grid applications often involve large amounts of data and/or computing resources that require secure resource sharing across organizational boundaries. This makes Grid application management and deployment a complex undertaking. Grid middlewares provide users with seamless computing ability and uniform access to resources in the heterogeneous Grid environment. Several software toolkits and systems have been developed, most of which are results of academic research projects, all over the world. This paper presents an introduction to Grid computing and discusses two complimentary Grid technologies: Globus developed by researchers from Argonne National Laboratory and University of Southern California, USA; and Gridbus by researchers from the University of Melbourne, Australia. Globus primarily focuses on providing core Grid services whereas Gridbus focuses on providing user-level Grid services in addition to utility computing model for management of grid resources.

Keywords: Grid computing, e-Science, Grid middleware, Gridbus, and Globus.

1 Introduction

The last decade has seen a substantial increase in commodity computing and network performance, mainly as a result of faster hardware and more sophisticated software. These commodity technologies have been used to develop low-cost high-performance computing systems, popularly called clusters, to solve resource-intensive problems in a number of application domains. Particularly, in the scientific arena, the availability of powerful computing resources has allowed scientists to broaden their simulations and experiments to take into account more parameters than ever before. Fast networks have made it possible to share data from instruments and results of experiments with collaborators around the globe almost instantaneously. Recently, research bodies have begun to launch ambitious programs that facilitate creation of such collaborations to tackle large-scale scientific problems. Collectively, such programs are termed eScience [1] to denote the pivotal role played by the computational infrastructure for enabling collaborative research. A typical eScience scenario is shown in Figure 1. eScience also envisages sharing scientific instruments such as particle accelerators (CERN Large Hadron Collider [2]), commissioned as national/international infrastructure due to the high cost of ownership.

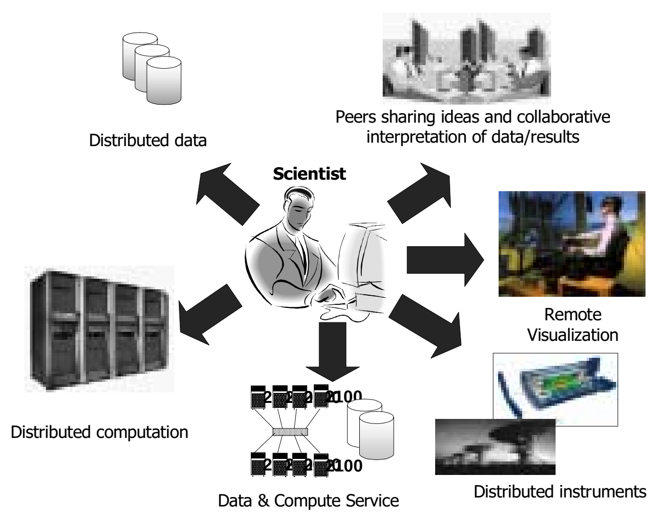

Fig. 1: A typical eScience scenario.

As a consequence of the large collaborations and the increased computational power, the data generated and analysed within eScience programs are both massive and inherently distributed.

Therefore, the challenges of such environments revolve around data – managing its access, distribution, processing and storage. These challenges thus motivate creation of a computational infrastructure by coupling wide-area distributed resources such as databases, storage servers, high-speed networks, supercomputers and clusters for solving large-scale problems, leading to what is popularly known as Grid computing [3] [4] [5]. This is analogous to the electrical power grid that provides consistent, pervasive, dependable, transparent access to electric power irrespective of its source.

As there are a large number of projects around the world working on developing Grids for different purposes at different scales, several definitions of Grid abound. The Globus Project defines Grid as "an infrastructure that enables the integrated, collaborative use of high-end computers, networks, databases, and scientific instruments owned and managed by multiple organizations." Another utility notion based Grid definition put forward by the Gridbus Project is "Grid is a type of parallel and distributed system that enables the sharing, selection, and aggregation of geographically distributed "autonomous" resources dynamically at runtime depending on their availability, capability, performance, cost, and users' quality-of-service requirements."

The development of the Grid infrastructure, both hardware and software, has become the focus of a large community of researchers and developers in both academia and industry. The major problems being addressed by Grid developments are the social problems involved in collaborative research:

- improving distributed management whilst retaining full control over locally managed resources;
- improving the availability of data and identifying problems and solutions to data access patterns; and
- providing researchers with a uniform user-friendly environment that enables access to a wider range of physically distributed facilities improving productivity.

A high-level view of activities involved within a seamless and scalable Grid environment is shown in Figure 2. Grid resources are registered within one or more Grid information services. The end users submit their application requirements to the Grid resource broker which then discovers suitable resources by querying the Information services, schedules the application jobs for execution on these resources and then monitors their processing until they are completed. A more complex scenario would involve more requirements and therefore, Grid environments involve services such as security, information, directory, resource allocation, application development, execution management, resource aggregation, and scheduling. Software tools and services providing these capabilities to link computing capability and data sources in order to support distributed analysis and collaboration are collectively known as Grid middleware.

In order to provide users with a seamless computing environment, the Grid middleware systems need to solve several challenges originating from the inherent features of the Grid [6]. One of the main challenges is the heterogeneity that results from the vast range of technologies, both software and hardware, encompassed by the Grid. Another challenge involves the handling of Grid resources that are spread across political and geographical boundaries and are under the administrative control of different organizations. It follows that the availability and performance of Grid resources are unpredictable as requests from within an administrative domain may gain more priority over requests from outside. Thus, the dynamic nature of Grid environment poses yet another challenge.

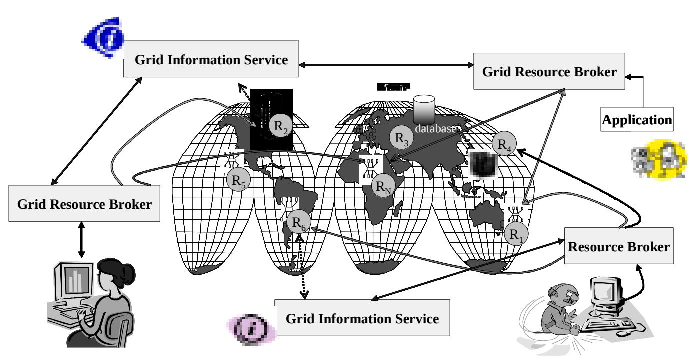

Fig. 2: A world-wide Grid computing environment.

To tackle these challenges, a Grid architecture has been proposed based on the creation of Virtual Organizations (VOs)

[7] by different physical (real-world) organizations coming together to share resources and collaborating in order to achieve a common goal. A VO defines the resources available for the participants and the rules for accessing and using the resources. Within a VO, participants belonging to member organizations are allocated resource share based on urgency and priority of a request as determined by the objectives of the VO. Another complimentary Grid architecture [8] is based on economic principles in which resource providers (owners) compete to provide the best service to resource consumers (users) who select appropriate resources based on their specific requirements, the price of the resources and their expectations of Quality-of-Service (QoS) from the providers. Two examples of QoS terms are the deadline by which the resource needs to be available and the maximum price (budget) that can be paid by the user for the service. QoS terms are enforced via SLAs (Service Level Agreements) between the providers and the consumers, the violation of which results in penalties.

2 Grid Components

In a world-wide Grid environment, capabilities that the infrastructure needs to support include:

- Remote storage and/or replication of data sets
- Publication of datasets using global logical name and attributes in the catalogue
- Security –access authorisation and uniform authentication
- Uniform access to remote resources (data and computational resources)
- Publication of services and access cost
- Composition of distributed applications using diverse software components including legacy programs.
- Discovery of suitable datasets by their global logical names or attributes
- Discovery of suitable computational resources
- Mapping and Scheduling of jobs (Aggregation of distributed services)
- Submission, monitoring, steering of jobs execution
- Movement of code/data between the user desktop machines and distributed resources
- Enforcement of quality of service requirements
- Metering and Accounting of resource usage

The above capabilities in Grid computing environments play a significant role in enabling a variety of scientific, engineering, and business applications. Various Grid components providing the above capabilities are arranged into layers. Each layer builds on the services offered by the lower layer in addition to interacting and co-operating with components at the same level (e.g., Resource broker invoking secure process management services provided by core middleware). Figure 3 shows the hardware and software stack within a typical Grid architecture. It consists of four layers: fabric, core middleware, user-level middleware, and applications and portals layers.

Grid Fabric layer consists of distributed resources such as computers, networks, storage devices and scientific instruments. The computational resources represent multiple architectures such as clusters, supercomputers, servers and ordinary PCs which run a variety of operating systems (such as UNIX variants or Windows). Scientific instruments such as telescope and sensor networks provide real-time data that can be transmitted directly to computational sites or are stored in a database.

Core Grid middleware offers services such as remote process management, co-allocation of resources, storage access, information registration and discovery, security, and aspects of Quality of Service (QoS) such as resource reservation and trading. These services abstract the complexity and heterogeneity of the fabric level by providing a consistent method for accessing distributed resources.

User-level Grid middleware utilizes the interfaces provided by the low-level middleware to provide higher level abstractions and services. These include application development environments, programming tools and resource brokers for managing resources and scheduling application tasks for execution on global resources.

Grid applications and portals are typically developed using Grid-enabled programming environments and interfaces and brokering and scheduling services provided by user-level middleware. An example application, such as parameter simulation or a grand-challenge problem, would require computational power, access to remote datasets, and may need to interact with scientific instruments. Grid portals offer Web-enabled application services, where users can submit and collect results for their jobs on remote resources through the Web.

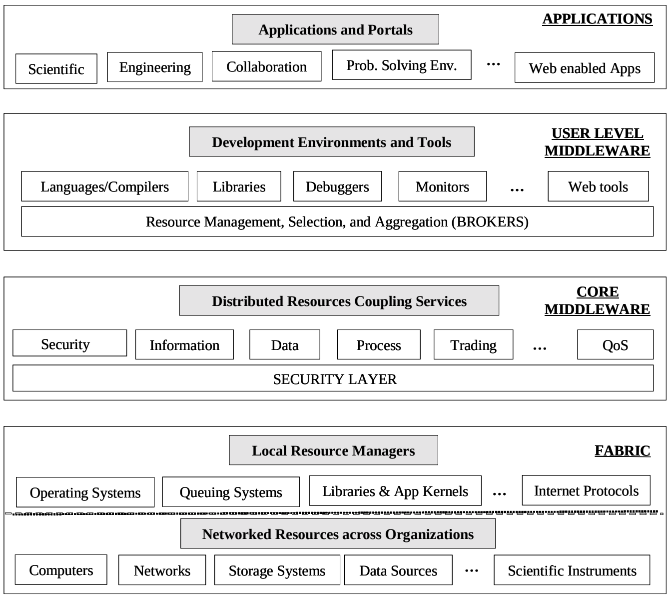

Fig. 3: A Layered Grid Architecture and components.

2.1 Operational Flow from Users' Perspective

Figure 4 shows Grid environment from an operations perspective with the components organized according to their deployment and functionality. To make resources constituents of the Grid, they need to be accessible from different management domains. This can be achieved by installing core Grid middleware such as Globus in Unix/Linux environment and Alchemi in Windows environment. Multi-node resources such as clusters need to be presented as a single resource to the Grid and this can be achieved by deploying job management systems such as Condor, PBS, or Sun Grid Engine on them. In a Grid environment where data needs to be federated for sharing among various interested parties, data grid technologies such as SRB, Globus RLS, or EU Data Grid needs to be deployed. The user-level middleware need to be deployed on resources responsible for providing resource brokering and application deployment services. The users may even accesses these services via Web portals.

In eScience Grid environments such as those established for LHC (Large Hadron Collider) data sharing and analysis, the key steps involved and the interaction between various grid components are as follows (see Figure 4):

1. The users compose their application as a distributed application (e.g., parameter sweep) using visual application development tools.
2. The users specify their analysis and quality-of-service requirements and submit them to the Grid resource broker.
3. The Grid resource broker performs resource discovery and their characteristics using the Grid information service.
4. The broker identifies resource service prices by querying the Grid market directory.
5. The broker identifies the list of data sources or replicas and selects the optimal ones.
6. The broker also identifies the list of computational resources that provides the required application services.
7. The broker ensures that the user has necessary credit or authorized share to utilise resources.
8. The broker scheduler maps and deploys data analysis jobs on resources that meet user quality-of-service requirements.
9. The broker agent on a resource executes the job and returns results.
10. The broker collates the results and passes to the user.
11. The metering system charges the user by passing the resource usage information to the accounting system.

The accounting system reports resource share allocation or credit utilisation to the user.

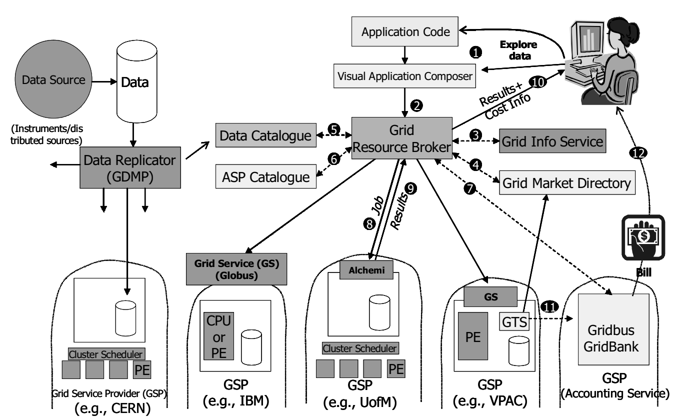

Fig. 4: Grid technologies for analysis of distributed data.

3 Grid Initiatives World-Wide

Given the possibilities of Grid computing, it is no surprise that there is a huge interest in this technology around the world. Currently, Grid projects that have been initiated around the world can be broadly classified into two classes: (1) Grid infrastructure development that involves setting up hardware, software and administrative mechanisms so that application scientists can make use of these facilities for their research and (2) Grid middleware research that investigates on the development of software and policy mechanisms that assist in realizing the full potential of Grid computing. Many of these projects are motivated by large-scale scientific projects that will involve production and analysis of data at an unprecedented scale. Often cited such large-scale scientific projects are the LHC experiments (CMS, ATLAS, Alice, LHCb) at CERN when they will begin data production in 2007. The volume of data that is expected to be generated by these experiments is expected to be in petabytes (PB) which need to be distributed to physicists around the world for analysis. As the Grid has been mandated as the IT infrastructure for handling the massive workloads of the LHC experiments, all the collaborating nations are setting up Grid infrastructure in one form or another. In the following sections, we will state some of the major Grid infrastructure and middleware projects around the world.

3.1 United States

Production Grid testbeds for various application domains have been deployed over physical (hardware) Grid infrastructure such as the US NSF (National Science Foundation)-funded TeraGrid that provides over 40 teraflops of computing power at eight sites around the US with 2 PB of available storage interconnected by 10-30 gigabits per second network. One of the major testbeds is Grid3 which covers 25 sites across US and Korea that are used collectively for application domains such as High-Energy Physics, Astronomy and Biology. Other Grid projects setting up testbeds include GriPhyN (Grid Physics Network), PPDG (Particle Physics Data Grid), LIGO (Laser Interferometer Gravitational-Wave Observatory) and SDSS (Sloan Digital Sky Survey). The BioInformatics Research Network (BIRN) is another testbed for the purpose of furthering biomedical science by sharing data stored in different repositories around US. NEESGrid enables scientists in the earthquake engineering community to carry out experiments in distributed locations and analyse data through a uniform interface.

Out of the Grid middleware efforts in the United States, the Globus Toolkit from the Globus Alliance led by Argonne National Laboratory is the most widely known. We will be discussing this in detail later in this article. SRB (Storage Resource Broker) from San Diego Supercomputing Centre is another widely deployed middleware for federating disparate repositories and takes care of data storage, replication and access management. Other notable efforts are the Condor project (University of Wisconsin, Madison) for high throughput computing mechanisms, AppLeS (University of California, San Diego) for application scheduling, GrADS project headed by Rice University for application development environment, NetSolve (University of Tennessee, Knoxville) which develops libraries for Grid RPC (Remote Procedure Call) applications, and the Virtual Data Grid (VDG) project that is looking into reuse of data products for future executions. In addition, several commercial organizations such as IBM, Sun, HP, and Oracle are actively involved in the development of enterprise and global utility Grid technologies. [An article by Gentzsch in this special issue presents commercial Grid efforts in detail.]

3.2 Europe

The two major Grid efforts in Europe, started in early 2001, are the United Kingdom (UK)'s e-Science program and the European Union funded Data Grid project which is now succeeded by the EGEE (Enabling Grids for E-sciencE) project. The UK e-Science program proposed to focus on the promotion and advancement of UK involvement in the Grid through infrastructure provision, and development of Grid middleware. EGEE focuses on developing a Grid infrastructure available to scientists and to develop robust middleware for application deployment.

CERN, the European Organization for Nuclear Research, and the High-Energy Physics (HEP) community have established an International Data Grid project with intent to apply the work to other scientific communities such as Earth Observation and Bioinfomatics. The project objectives are to establish a research network for data Grid technology development, demonstrate data Grid effectiveness through the large-scale real world deployment of end-to-end application experiments, and to demonstrate the ability to use low-cost commodity components to build, connect, and manage large general-purpose, data intensive computer clusters.

Other notable EU funded projects include GridLab providing application development toolkit, Cactus framework for scientific programming, GridSphere for creating a web portal environment for Grid users, P-Grade providing visual environment for application development, and Triana for workflow formulation. OGSA-DAI, part of UK e-Science program, supports integration of relational databases in Grid environments.

3.3 Asia-Pacific

Several countries in the Asia-Pacific region have started national Grid programs similar to those initiated in United States and Europe. In addition, countries such as Australia, China, Japan, South Korea and Singapore are active participants in worldwide Grid projects such as the LHC Computational Grid (LCG) and the Virtual Observatory projects. Some of the notable Grid programs are the NAREGI (National Research Grid Initiative) in Japan, APAC Grid (Australia), China National Grid (China), K*Grid (South Korea) and APGrid (Asia Pacific Grid).

Prominent Grid middleware projects include Ninf project (Tokyo Institute of Technology) for building a Grid-based RPC (remote procedure call) system, the Grid Datafarm (Gfarm) project (AIST, Japan) for providing a petascale data storage and processing system, the Nimrod project (Monash University, Australia) for parametric computations on Grid resources and the Gridbus project (University of Melbourne, Australia) for service-oriented utility computing. We will look at the Gridbus project in detail later in this article.

3.4 India

Centre for Development of Advanced Computing is setting up Grid infrastructure by connecting supercomputers such as PARAM 10000 by high-speed networks. The Indian Institute of Information Technology and Management, Kerala is heading a Grid project that aims to bring educational materials closer to educators wherever they are located. Known as Kerala Education Grid, this project envisages the linking of colleges and universities to resource centres that will supply education materials on demand and increase cooperation and networking among the affiliated academics. [see an article by Sherly in this special issue for details on Kerala Education Grid.]

Information Technology companies in India have shown great interest in the potential of Grid technology for obtaining the maximum benefits out of enterprise infrastructure. Corporations such as Infosys and Satyam have already started initial forays into this area.

3.5 Standardization Efforts

Given the large amount of middleware development happening in this area of research, standardization is important to ensure interoperability between different products and implementations. In the past few years, Grid standardization efforts led by the Global Grid Forum (GGF) [9] have produced standards for almost all aspects of Grid technology. Work at the GGF have produced the Open Grid Service Infrastructure (OGSI) specification and its successor, the Web Services Resource Framework (WSRF) that pave the way for integration of Web Services within Grid architecture. This is important as Web Services allow Grid developers to take advantage of standard message formats and communications mechanisms such as HTTP and XML for communicating between heterogeneous components and architectures. Other standardization bodies such as W3C (World Wide Web Consortium), OASIS (Organization for Advancement of Structured Information Standards) and IETF (Internet Engineering Task Force) also produce standards relevant to aspects of Grid Computing.

In the following sections, we will take a look at two different middleware projects – the Globus Toolkit [9] and the Gridbus Project [11]. The Globus toolkit is widely used and provides the functionalities of core Grid middleware as mentioned above. The Gridbus Project, while extending across the Grid middleware stack, concentrates more on user-level middleware with special emphasis on economy based Grid resource management guided by user-defined QoS attributes.

4 Globus Toolkit

The Globus project provides open source software toolkit that can be used to build computational grids and grid based applications. It allows sharing of computing power, databases, and other resources securely across corporate, institutional and geographic boundaries without sacrificing local autonomy. The core services, interfaces and protocols in the Globus toolkit allow users to access remote resources seamlessly while simultaneously preserving local control over who can use resources and when. The Globus architecture, shown in Figure 5, has three main groups of services accessible through a security layer. These groups are Resource Management, Data management and Information Services.

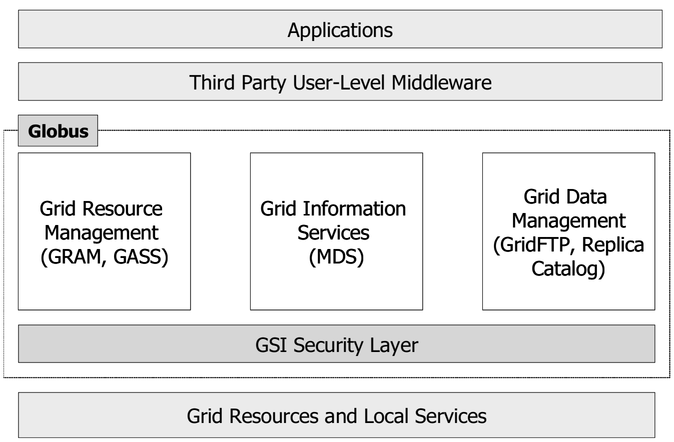

Fig. 5: The Globus Architecture.

The local services layer contains the operating system services, network services like TCP/IP, cluster scheduling services provided by Load Leveler, job-submission, query of queues, and so on. The higher layers of the Globus model enable the integration of multiple or heterogeneous clusters. The core services layer contains the Globus toolkit building blocks for security, job submission, data management, and resource information management. The high-level services and tools layer contains tools that integrate the lower level services or implement missing functionality.

4.1 GSI Security Layer:

The Grid Security Infrastructure (GSI) provides methods for authentication of Grid users and secure communication. It is based on SSL (Secure Sockets Layer), PKI (Public Key Infrastructure) and X.509 Certificate Architecture. The GSI provides services, protocols and libraries to achieve the following aims for Grid security:

- Single sign-on for using Grid services through user certificates
- Resource authentication through host certificates
- Data encryption
- Authorization
- Delegation of authority and trust through proxies and certificate chain of trust for certificate authorities

Users gain access to resources by having their Grid certificate subjects mapped to an account on the remote machine by its system administrators. This also requires that the CA that signed the user certificate be trusted by the remote system. Access permissions have to be enforced in the traditional UNIX manner through restrictions on the remote user account.

CAs (Certificate Authorities) are also a part of realising the notion of VOs. A user who has a certificate signed by the CA of the VO gains access to the resources authenticated by the same CA. VOs can cooperate between themselves by recognizing each others CAs so that users can access resources between collaborations. These mechanisms are used in many Grid testbeds. Depending on the structure of the testbed and the tools used, the users may gain access automatically to the resources or may have to contact the system administrators individually to ensure access.

Most services require mutual authentication before carrying out their functions. This guarantees non-repudiability and data security on both sides. However, the current state of GSI tools makes it more likely that some users may share the usage of a single certificate to gain access to higher number of resources or that they may be mapped to the same account on the remote machine. This may raise serious questions on the authenticated users and the confidentiality of user data on the remote machine. Production testbeds have policies in place to restrict this behaviour but there is still some way to go before these are restricted at the middleware level.

4.2 Resource Management:

The resource management package enables resource allocation through job submission, staging of executable files, job monitoring and result gathering. The components of Globus within this package are:

Globus Resource Allocation Manager (GRAM): GRAM provides remote execution capability and reports status for the course of the execution. A client requests a job submission to the gatekeeper daemon on the remote host. The gatekeeper daemon checks if the client is authorized (i.e., the client certificate is in order and there is a mapping of the certificate subject to any account on the system). Once authentication is over, the gatekeeper starts a job manager that initiates and monitors the job execution. Job managers are created depending on the local scheduler on that system. GRAM interfaces to various local schedulers such as Portable Batch System (PBS), Load Sharing Facility (LSF) and LoadLeveler.

The job details are specified through the Globus Resource Specification Language (RSL), which is a part of GRAM. RSL provides syntax consisting of attribute-value pairs for describing resources required for a job including the minimum memory and the number of CPUs.

Globus Access to Secondary Storage (GASS): GASS is a file-access mechanism that allows applications to pre-fetch and open remote files and write them back. GASS is used for staging-in input files and executables for a job and for retrieving output once it is done. It is also used to access the standard output and error streams of the job. GASS uses secure HTTP based streams to channel the data and has GSI-enabled functions to enforce access permissions for both data and storage.

4.3 Information Services:

The information services package provides static and dynamic properties of the nodes that are connected to the Grid. The Globus component within this package is called Monitoring and Discovery Service (MDS).

MDS provides support for publishing and querying of resource information. Within MDS, schema define classes that represent various properties of the system. MDS has a three-tier structure at the bottom of which are Information Providers (IPs) that gather data about resource properties and status and translate them into the format defined by the object classes. The Grid Resource Information Service (GRIS) forms the second tier and is a daemon that runs on a single resource. GRIS responds to queries about the resource properties and updates its cache at intervals defined by the time-to-live by querying the relevant IPs. At the topmost level, the GIIS (Grid Information Index Service) indexes the resource information provided by other GRISs and GIISs that are registered with it.

4.4 Data Management:

The data management package provides utilities and libraries for transmitting, storing and managing massive data sets that are part and parcel of many scientific computing applications. The elements of this package are:

GridFTP: It is an extension of the standard FTP protocol that provides secure, efficient and reliable data movements in grid environments. In addition to standard FTP functions, GridFTP provides GSI support for authenticated data transfer, third-party transfer invocation and striped, parallel and partial data transfer support.

Replica Location and Management: This component supports multiple locations for the same file throughout the grid. Using the replica management functions, a file can be registered with the Replica Location Service (RLS) and its replicas can be created and deleted. Within RLS, a file is identified by its Logical File Name (LFN) and is registered within a logical collection. The record for a file points to its physical locations. This information is available from the RLS upon querying.

The major Grid tools and application projects making use of Globus as their low-level middleware include: AppLeS, Ninf, Nimrod-G, NASA IPG, Condor-G, Gridbus Broker, UK eScience Project, GriPhyN, and EU Data Grid.

5 Gridbus Middleware

Grid technologies such as Globus provide capabilities and services required for secure access and execution of a job on a resource in a uniform manner on heterogeneous resources. However, to achieve the complete vision of Grid as a utility computing environment, a number of challenges need to be addressed. They include composition of analysis software as a distributed application, resource brokering methodologies and strategies for scheduling data-driven applications, data Grid economy for data management, application service specification, and accounting of resource consumption. The application development and deployment services need to scale from desktop environment to global Grids and need to support both scientific and business applications.

The Gridbus project is engaged in the design and development of service-oriented cluster and Grid middleware technologies to support eScience and eBusiness applications. It extensively leverages related software technologies and provides an abstraction layer to hide idiosyncrasies of heterogeneous resources and low-level middleware technologies from application developers. In addition, it extensively focuses on realization of utility computing model scaling from clusters to Grids and to peer-to-peer computing systems. It uses economic models in efficient management of shared resources and promotes commoditization of their services. Thus, it enhances the tradability of Grid services and manages efficiently the supply and demand for resources.

Gridbus supports commoditization of Grid services at various levels:

- Raw resource level (e.g., selling CPU cycles and storage resources)
- Application level (e.g., molecular docking operations for drug design application)
- Aggregated services (e.g., brokering and reselling of services across multiple domains)

The idea of a computational economy helps in creating a service-oriented computing architecture where service providers offer paid services associated with a particular application and users, based on their requirements, would optimize by selecting the services they require and can afford within their budget. Gridbus emphasizes the end-to-end quality-of-services driven by computational economy at various levels - clusters, peer-to-peer (P2P) networks, and the Grid - for the management of distributed computational, data, and application services.

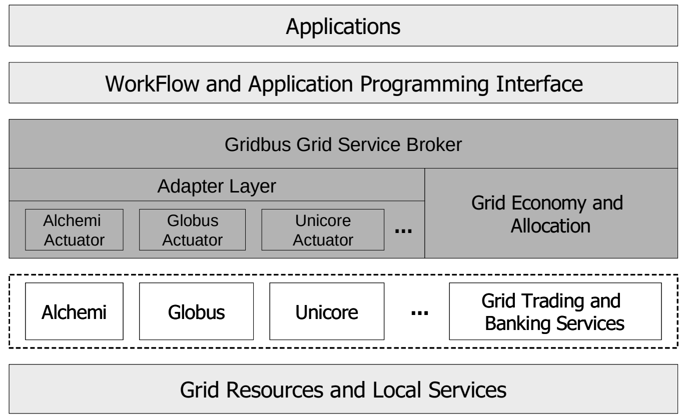

Fig. 6: The Gridbus Architecture.

Figure 6 shows a layered architecture depicting the Gridbus components in conjunction with other middleware technologies such as Globus that have been discussed before. Gridbus provides software technologies that spread across the following categories:

- Enterprise Grid Middleware (Alchemi)
- Service-Level Agreements based Allocation of Cluster Resources (Libra)
- Grid Economy and Virtual Enterprise (Grid Market Directory, Compute Power Market)
- Grid Trading and Accounting Services (GridBank)
- Grid Resource Brokering and Scheduling (Gridbus Broker)
- Grid Workflow Management (Gridbus Workflow Engine)
- Grid Application Programming Interface (Visual Parametric Modeller)
- Grid Portals (GMonitor, Gridscape)
- Grid Modeling and Simulation (GridSim)

Alchemi: Though scientific computing facilities have been heavy users of Unix-class operating systems, the vast majority of computing infrastructure within enterprises is still based on Microsoft Windows. Alchemi was developed to address the need within enterprises for a desktop grid solution that utilizes the unused computational capacity represented by the vast number of PCs and workstation running Windows within an organization. Alchemi is implemented on top of the Microsoft .NET Framework and provides the runtime machinery for constructing and managing desktop Grids. It also provides an object-oriented programming model along with web service interfaces that enable its services to be accessed from any programming environment that supports SOAP-XML abstraction.

Libra: Libra is a cluster scheduling system that performs service-level agreements based allocation of resources. It guarantees a certain share of the system resources to a user job such that the job is completed by the deadline specified by the user provided he has the requisite budget for it. Jobs whose output is required immediately require a higher budget than those with a more relaxed deadline. Thus, Libra delivers utility value to the cluster users and increases their satisfaction by creating realistic expectations for the job turnaround times.

Grid Market Directory (GMD): It provides registry service where service providers can register themselves and publish the services they're providing and consumers can query to obtain the service that meets their requirements. Some of the attributes of a service are its access point, input mechanism and the cost involved in using it.

Compute Power Market (CPM): It is a market-based resource management and scheduling system developed over the JXTA platform. It enables trading of idle computational power over P2P networks. The CPM components that represent markets, consumers and providers are Market Server, Market Resource Agent, and Market Resource Broker (MRB). It supports various economic models for resource trading and matching service consumers and providers and allows plugging in of different scheduling mechanisms.

Accounting and Trading Services: GridBank is a Grid-wide accounting and micro-payment service that provides a secure infrastructure for Grid Service Consumers (GSCs) to pay Grid Service Providers (GSPs) for the usage of their services. The consumer is charged on the basis of resource usage records maintained by the provider and service charges that have been agreed upon by both parties in the beginning. GridBank can also be used as an authentication and authorization mechanism thereby ensuring access to the resources to only those consumers with the requisite credit in their accounts.

Resource Broker: The Gridbus Resource Broker provides an abstraction to the complexity of Grids by ensuring transparent access to computational and data resources for executing a job on a Grid. It uses user requirements to create a set of jobs, discover resources, schedule, execute and monitor the jobs and retrieve their output once they are finished. The broker supports a declarative and dynamic parametric programming model for creating Grid applications.

The Gridbus broker has the capability to locate and retrieve the required data from multiple data sources and to redirect the output to storage where it can be retrieved by processes downstream. It has the ability to select the best data repositories from multiple sites based on availability of files and quality of data transfer.

Web Portals: G-monitor is a web-portal for monitoring and steering computations on global Grids. G-monitor interfaces with resource brokers such as Gridbus broker and Nimrod-G and uses their services to initiate and monitor application execution. It provides the user with up-to-date information about the progress of the execution at the individual job level and at the overall experiment level. At the end of the execution, the user can collect the output files through G-monitor.

Gridscape: It is tool for creation and generation of interactive and dynamic portals that enable users to view the status of the resources within the testbed and easily add new resources when required. It is also possible to customize the portal to reflect the unique identity of the organization managing the testbed.

Modeling and Simulation: The GridSim toolkit provides facilities for the modeling and simulation of resources and network connectivity with different capabilities, configurations and domains. It supports primitives for application composition, information services for resource discovery and interfaces for assigning application tasks to resources and managing their execution. It also provides a visual modeler interface for creating users and resources. These features can be used to simulate parallel and distributed scheduling systems such as resource brokers or Grid schedulers for evaluating performance of scheduling algorithms or heuristics.

Gridbus technology has been used in creating a range of e-Science and e-Business applications from reading brainwaves and early detection of breast cancer to searching for cosmic particles and developing finance portfolio analysis. Some prominent usages include: (1) Osaka University, Japan has developed a Gridbus-based neuroscience application that helps in Brain Activity Analysis, (2) Friedrich Miescher Institute for Biomedical Research, Switzerland has used Gridbus technology in their distributed bioinformatics platform that helps in identification of patterns of transcription factors in the regulatory regions of mammalian genes, (3) Tier Technologies, USA has used in OCR data processing, and (4) CSIRO Land and Water Division and CRC for Catchment Hydrology in Australia have used our Gridbus technology in distributed processing of environmental simulation models.

6 Summary and Conclusion

To summarize, we have shown how Grid computing is becoming the preferred platform for next generation eScience experiments that require management of massive distributed data. We have covered some of the major Grid efforts around the world and discussed the Grid software stack with two sample technologies – the Globus Toolkit and the Gridbus middleware. A number of scientific and commercial applications have started harnessing Grids. It can be observed that while there has been a lot of development for Grid technologies for eScience, there is still more to be achieved in terms of Grids providing computing utilities in the same manner as power utilities supply electric power. Ultimately, this would require development of richer services and applications on top of already existing ones so that Grid computing can move beyond scientific applications and into mainstream IT infrastructure.

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Data Grid Architecture for a Distributed Data Management System: Kerala Education Grid Perspective

Elizabeth Sherly[1]

It has been realized that by 2010 a million times of storage capacity of an average desktop computer will be needed and the computing power will have to be increased by 20-30 teraflops per second of the computing power. Grid computing, which enables a flexible, secure, and coordinated resource sharing is a promise and the data grid provides a vital role in managing, storing and coordinating data dynamically in a large distributed systems.

The challenges involved in emerging web-based e-learning system to create a knowledge society is not only the information sharing, but to dynamically locate, manage and present information to the user in an efficient way. This paper presents a data grid framework for architecting and managing information for a distributed e-learning system.

1. Introduction

Over the past decade, the technology behind computational grid has evolved from raw concepts to a tangible reality. It is time to add Information Technology too to the list of essentials just like water, power, gas and telephones, you need to pay only for the services without owning a mobile phone, super computer, scanner etc. The awesome power of grid computing provides a collaborative problem solving environment that make the next generation life much more comfortable and easy.

Access to Distributed data is as important as access to Computational Resources. Data is very crucial and is becoming a community resource in many scientific and commercial Applications. Data grid provides a next generation computing infrastructure for a collaborative problem-solving environment with intensive computation and analysis of shared large-scale databases, from hundreds of Terabytes to Peta bytes, across widely distributed environment.

In this paper we develop grid middleware architecture for Kerala Education Grid Project[3], a Kerala Government initiative to connect various colleges and universities to provide quality education to all through a web based learning environment. It deals with large volume of multimedia enriched course materials distributed in multiple servers across Kerala.

Globus Toolkit, an open source with modular bag of technologies for developing grid application is powerful to handle various services for seamless information processing in a distributed environment. Globus 3.2 is used in this application to share and manage large volumes of contents and to transfer the data in a heterogeneous environment.

2. Kerala Education Project

Kerala Education Grid is a project undertaken by Kerala Government to provide quality education to all students of higher education in the state. It addresses a collaborative approach of subject-specific knowledge sharing and support for teachers across a network of universities, premier institutions and colleges.

This is a technology-enhanced learning and teaching programme with the intention to provide the teachers and students much of the supplementary learning resources in a web based learning environment. The Course Management System consists of course materials of various subjects,

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enriched with Digital Library, which contains lot of supporting documents, streamed videos, technical and scientific journals and publications etc.

The Kerala Education Grid is to work in a statewide backbone network by initially connecting three resource centers and the colleges to each resource centers. The content development and deployment is distributed within these servers with a formal approval [3]. There will be a backbone network, which connects the colleges and universities with a reasonable bandwidth. The main Education Grid Resource centers are located in different locations. The major contents will be available in these three centers and has to be distributed to different colleges linked through servers, which are locally available. The architecture of networking the institute is given in Figure 2.1.

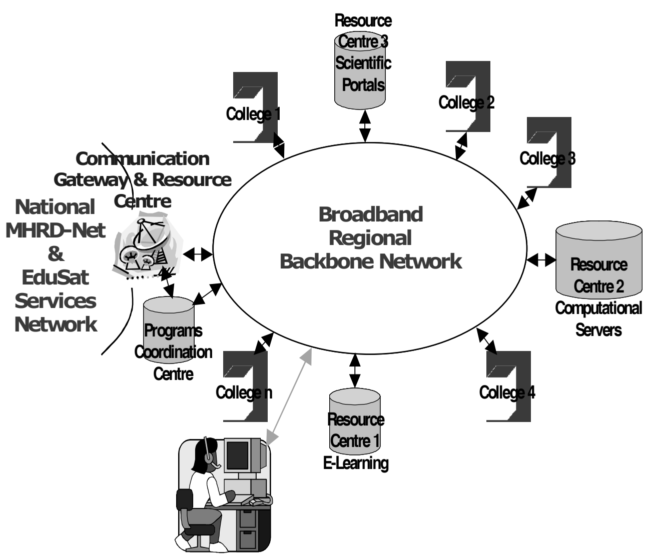

Fig. 2.1 Network Architecture of Education Grid.

The challenge in this project is not merely the setting up of network, but the design of an architecture, which can address the entire problems that may be faced in the later stages as the number of users and content volume increases. The effective delivery of contents to a large community, which include teachers, and students of the colleges or universities is a big challenge. The delivery of content in a heterogeneous manner and delivery of the content with minimal link time are some of the main concerns of the project. The datagrid architecture proposed here envisages the transfer of large volumes of multimedia-enriched contents in the Education Grid.

3. Data Transfer in DATA GRID

The three ways to transfer data in a grid environment are GridFTP, Reliable File Transfer and Replica Location Service.

GridFTP

GridFTP protocol provides a secure, robust, fast and efficient transfer of data in grid environment. It has been available in Globus 2.x is done by a server implementation called globus-gridftp-server, client side implementation using globus-url-copy and a set of development libraries for custom clients. This utility can be developed in JAVA COG Kit API of Globus toolkit. Using GridFTP, user can set robust and flexible authentication, integrity and confidentiality using Grid Security Infrastructure (GSI), multiple channels can be used for parallel data transfer, and data can be transferred from starting from any offset etc.

Reliable File Transfer

Though GridFTP is a powerful tool, it doesnot support web services and also requires an open socket connection in the client to the server throughout the transfer. Globus 3.2 provides Open Grid Services Architecture (OGSA), which is a combination of elements from web services and grid services. OGSA defines mechanisms to create, manage, and exchange information between grid services which enables to dynamically locate, manage and assure quality performance from participating systems.

Globus 4.0 is a Web Services Resource Framework (WSRF) compliant that provides job scheduler like functionality for data movement. You simply provide a list of source and destination URLs and then the service writes your job description into a database and then moves the files on your behalf. Service methods are provided for querying the transfer status, or you may use standard WSRF tools provided in the Globus Toolkit to subscribe for notifications of state change events.

Replica Location Service

The Replica Location Service (RLS) is a system that maintains information about the physical locations of logical identifiers and provides access to this information. RLS maintains and provides access to mapping information from logical names for data items to target names. These target names may represent physical locations of data items, or an entry in the RLS may map to another level of logical naming for the data item.

4. Data Grid Architecture for Education Grid

The proposed architecture is a three-tier model with a physical layer, Grid layer and Application layer. The physical layer consists of the database layer, which provides the required storage for the content. The back up management dealt with this layer and enables quick recovery and restoration. Cluster servers take care of the load balancing where the data is managed and executed. The Grid layer runs the Globus toolkit. It acts as an agent who brings the requested resources to the data depository. In this project Globus 3.2 toolkit is used which supports the web services also. The application portal is running on the application layer where users can access the application and grid services. The Three layer Architecture for Datagrid model is given in Fig. 4.1

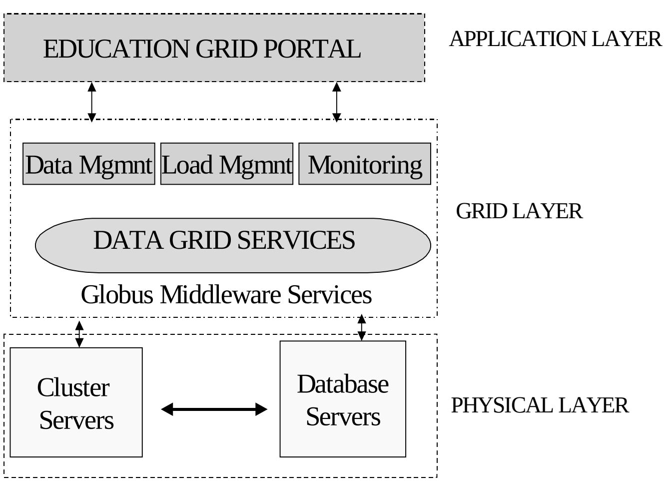

Fig. 4.1 Data Grid Architecture for Education Grid.

4.1 Implementation of Data Grid

GT 2.x provides GridFTP to transfer files in a better way and the remote execution of job, but doesnot attempt to provide a standard hosting environment that will guarantee the job execution correctly. That task is left to the user. The Grid Factory Services in OGSA of Globus 3.x, provides grid service to launch and couple together components to build the distributed application. Factory services enable solely to instantiate instances of specific application and resource requirements for an application to run, using separate handle and location for each instances[1].

Two services established here are File Services and Video Services in which different services are discovered, managed, named and used. Each service instances are created by factories; naming and bindings are done by unique name and services are managed by service data.

GridServicePortType is used for creation of various services, which defines the fundamental behavior of a service with introspection, discovery and soft state life management [2]. FilePortType and videoPortType are created using GWSDL using gwsdl namespace (gwsdl: portType) and the declaration of services and functions are made accessible to client applications through the use of GridServiceHandle (GSH) and GridServiceReference (GSR). GSH points to a grid service and is identified by a URI. The GSR contains the necessary identified information to access the service instance[4].

4.2 Portal Services

The services like Information Management, Resource Management, Monitoring and discovery systems are accessed from the application portal. Also services like administrative services, logging services, lifetime management, load balancing, and resource management have been monitored.

Information Management service provides a mechanism for service request to easily access the state of the service instance. Information Services are available from the index service, which caches and host the service data. The details of the client, login particulars, the course materials and video lectures selected and used are monitored from the portal. Service details such as Service name, Grid Service Handle, service access time, and service termination time are stored as service data.

Resource Management is done using GRAM architecture using Managed Job Factory Services [2]. From the client side, index service is created, client calls createserviceoperator on the factory. The factory creates the Managed Job Service and then returns to the locator. The client then returns the managed job services status.

Monitoring and Discovery System (MDS) is a suite of web services to monitor and discover resources and services on Grids. This system allows users to discover what resources are considered and to monitor those resources. MDS services provide query and subscription interfaces to arbitrarily detailed resource data and a trigger interface that can be configured to take action when pre-configured trouble conditions are met.

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SensorGrid: Integrating Sensor Networks and Grid Computing

Chen-Khong Tham[1] and Rajkumar Buyya[2]

Integrating sensor networks and grid computing in *sensor-grid computing* is like giving 'eyes' and 'ears' to the computational grid. Real-time information about phenomena in the physical world can be processed, modelled, correlated and mined to permit on-the-fly decisions and actions to be taken on a large scale. Examples include environment monitoring with prediction and early warning of natural disasters, and missile detection, tracking and interception. We describe some early work in sensor-grid computing, and discuss the research challenges that need to be overcome before such a vision can become reality, such as web services and service discovery, interconnection and networking, coordinated quality of service (QoS) mechanisms, robust and scalable distributed algorithms and efficient querying.

Keywords: Sensors, Sensor Networks, Grid computing, SensorML, SensorWeb.

1. Introduction

Recent advances in electronic circuit miniaturization and micro-electromechanical systems (MEMS) have led to the creation of small sensor nodes which integrate several kinds of sensors, a central processing unit (CPU), memory and a wireless transceiver. A collection of these sensor nodes forms a *sensor network* which is easily deployable to provide a high degree of visibility into real-world physical processes as they happen, thus benefitting a variety of applications such as environmental monitoring, surveillance and target tracking. Some of these sensor nodes may also incorporate actuators such as buzzers and switches which can affect the environment directly. We shall simply use the generic term sensor node to refer to these sensor-actuator nodes as well.

A parallel development in the technology landscape is *grid computing*, which is essentially the federation of heterogeneous computational servers connected by high-speed network connections. Middleware technologies such as Globus and Gridbus [1] enable secure and convenient sharing of resources such as CPU, memory, storage, content and databases by users and applications. This has caused grid computing to be referred to as 'computing on tap', utility computing and IBM's mantra, 'on demand' computing. Many countries have recognized the importance of grid computing for 'eScience' and the grid has a number of success stories from the fields of bioinformatics, drug design, engineering design, business, manufacturing and logistics.

The combination of sensor networks and grid computing in *sensor-grid computing* executing on a *sensor-grid architecture* (or simply a 'sensor-grid' in short) enables the complementary strengths and characteristics of sensor networks and grid computing to be realized on a single integrated platform – see Figure 1. Essentially, sensor-grid computing combines real-time data about the environment with vast computational resources. This enables the construction of real-time models and databases of the environment and physical processes as they unfold, from which high-value computations like decision-making, analytics, data mining, optimization and prediction can be carried out to generate 'on-the-fly' results. This powerful combination would enable, for example, effective early warning of natural disasters such as tornados and tsunamis, and real-time business process optimization.

The organization of this article is as follows. In Section 2, we describe a simple way to realize

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sensor-grid computing which we call the *centralized* approach. We then point out some of its weaknesses and describe a *distributed* approach. In Section 3, we describe two applications of distributed sensor-grid computing which we have implemented. In Section 4, the challenges and research issues related to sensor-grid computing are discussed. Finally, we conclude in Section 5.

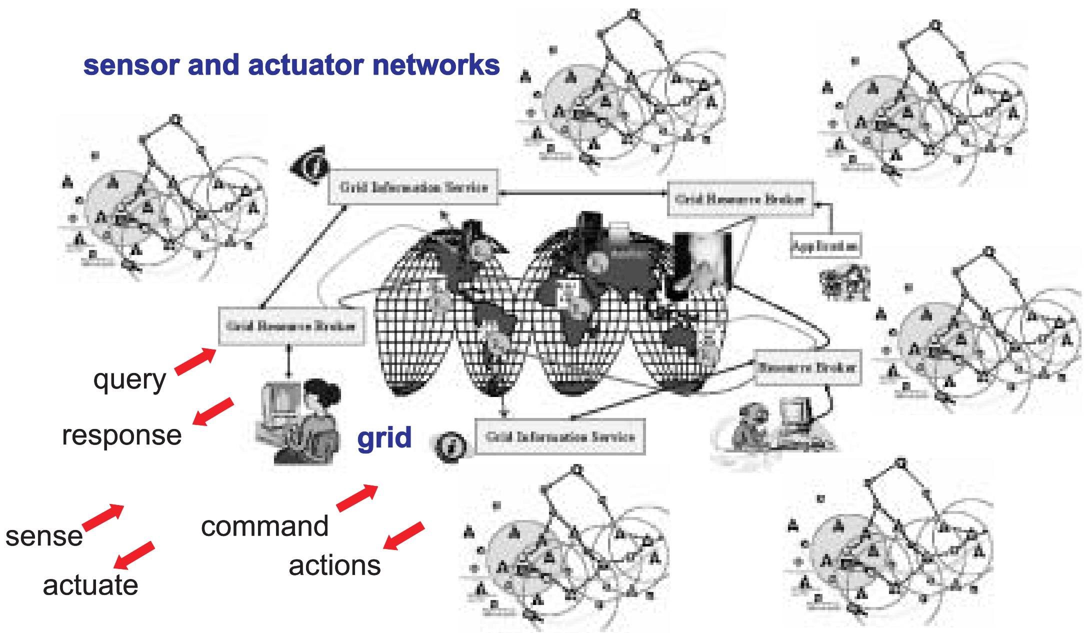

Fig. 1 - Sensor-Grid Architecture integrating Sensor Networks and Grid Computing.

2. Approaches to Sensor-Grid Computing

One simple way to achieve sensor-grid computing is to simply connect and interface sensors and sensor networks to the grid and let all computations take place there. The grid will then issue commands to the appropriate actuators. In this case, all that is needed are high-speed communication links between the sensor-actuator nodes and the grid. We refer to this as the *centralized sensor-grid computing* approach executing on a centralized sensor-grid architecture.

However, the centralized approach has several serious drawbacks. Firstly, it leads to excessive communications in the sensor network which rapidly depletes the batteries. It also does not take advantage of the in-network processing capability of sensor networks which permits simple processing and decision-making to be carried out close to the source of the sensed data. In the event of communication failure, such as when wireless communication in the sensor network is unavailable, e.g. due to jamming, the entire system becomes inoperational.

The more robust and efficient alternative is the decentralized or *distributed sensor-grid computing* approach which executes on a distributed sensor-grid architecture and alleviates most of the drawbacks of the centralized approach. The distributed sensor-grid computing approach involves processing and decision-making within the sensor network and at other levels of the sensor-grid architecture.

3. Implementations of Distributed Sensor-Grid Computing

Distributed information fusion and distributed decision-making are two applications that are well-suited for distributed sensor-grid computing.

3.1 Distributed information fusion

Since the nodes in a sensor network are independently sensing the environment, this gives rise to a high degree of redundant information. However, due to the severely resource-constrained nature of sensor nodes, some of these readings may be inaccurate. Information fusion algorithms compute the most probable sensor readings and have been studied extensively over the years in the context of target detection and tracking.

We implemented a hierarchical decision fusion system comprising two levels of Crossbow motes (at the local or ground level), grid clients (at the regional level) and grid server nodes (at the global level) to detect and classify forest fires of varying degrees of severity, ranging from 'local fire', 'small forest fire' to 'large forest fire'. The local classifier in each sensor node is a Bayesian Maximum A Posteriori (MAP) classifier and the decision fusion algorithm described in Duarte and Hu [2] is implemented at the fusion centers. During operation, the decision fusion algorithm produces the final classification outcome based on the most frequent class label among the training samples which produced the same decision vector as the one encountered during operation. This decision fusion algorithm is robust and produces high classification accuracy in the final classification even in the presence of faulty or noisy sensors.

In an enhanced version of the above, two further levels in the form of Stargate and iPAQ cluster heads were added between the sensor nodes and grid client levels. The resulting system can be seen in Figure 2. The addition of these two levels enable more complex processing to be done close to the source of the sensor data and reduces the communication distances between the different levels, thus conserving power and improving the timeliness of the global classification.

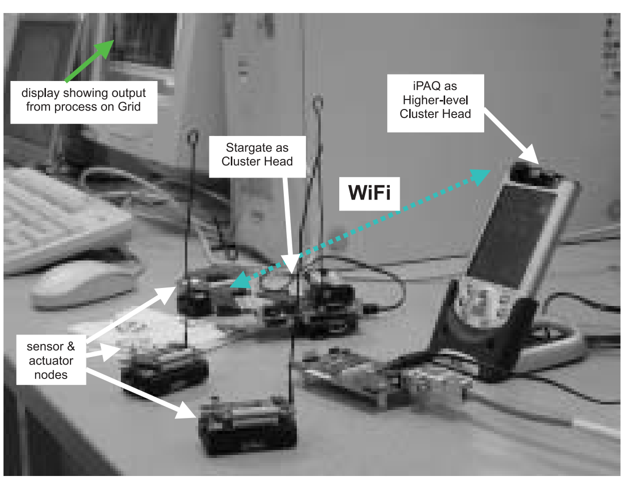

Fig. 2 – Hierarchical decision fusion system on sensor-grid architecture.

3.2 Distributed autonomous decision-making

There are many cases in which some response is needed from the sensor-grid system, but the best action to take in different situations or *states* is not known in advance. This can be determined through an adaptive learning process, such as the Markov Decision Process (MDP) or reinforcement learning (RL) [3] approach. MDP problems can be solved off-line using methods such as policy- or value-iteration, or on-line using RL or neuro-dynamic programming (NDP) methods.

A multi-level distributed autonomous decision-making system can be implemented on the hierarchical sensor-grid architecture shown in Figure 2. We implemented basic NDP agents in Crossbow motes at the local or ground level, and more complex NDP agents at grid server nodes at the core of the grid. Each NDP agent is able to act autonomously such that the entire sensor-grid remains responsive despite communication failures due to radio jamming, router faults etc.

4. Research Issues

Sensor networks is a relatively recent field and there are many research issues pertaining to sensor networks such as energy management, coverage, localization, medium access control, routing and transport, security, as well as distributed algorithms for target tracking, information fusion, inference and optimization.

Grid computing has been in existence longer, but nevertheless, still has a number of research challenges such as fair and efficient resource (i.e. CPU, network, storage) allocation to achieve QoS and high resource utilization, workflow management, the development of grid and web services for ease of discovery and access of services on the grid, and security. Resource allocation itself involves a number of aspects such as scheduling at the grid and cluster or node-levels, Service Level Agreements (SLAs) and market-based mechanisms such as pricing.

Apart from the afore-mentioned research issues in sensor networks and grid computing, sensor-grid computing gives rise to additional research challenges, especially when it is used in mission-critical situations. These research challenges are: web services and service discovery which work across both sensor networks and the grid, interconnection and networking, coordinated quality of service (QoS) mechanisms, robust and scalable distributed algorithms, and efficient querying. Each of these will be discussed in greater detail in the following sub-sections.

4.1 Web services-based Sensor Networks and Distributed Processing

The Grid is rapidly advancing towards a utility computing paradigm and is increasingly based on web services standards. The Service-Oriented Architecture (SOA) approach has become a cornerstone in many recent grid efforts. It makes good sense to have an SOA-approach as it enables the discovery, access and sharing of the services, data, computational and communication resources in the grid by many different users.

Likewise, in sensor networks, it makes sense to share the sensor-actuator infrastructure among a number of different applications and users so that the environment is not swamped with an excessive number of sensor nodes, especially since these nodes are likely to interfere with one another when they communicate over the shared wireless medium and decrease the effectiveness of each node, and actuators may also take conflicting actions.

There has been some recent work on adopting service-oriented architecture and web services approach to sensors and sensor networks. The OpenGeospatial Consortium's Sensor Model Language (SensorML) [6] standard provides the XML schema for defining the geometric, dynamic and observational characteristics of sensors. The purpose of SensorML is to:

(1) provide general sensor information in support of data discovery,

(2) support the processing and analysis of the sensor measurements,

(3) support the geolocation of the measured data,

(4) provide performance characteristics (e.g. accuracy, threshold, etc.), and

(5) archive fundamental properties and assumptions regarding sensor.

SensorML provides a functional model for sensor, not necessarily a detailed description of hardware. It supports rigorous geolocation models, which can describe sensor parameters independent of platform and target, as well as mathematical models which can directly map between sensor and target space. SensorML can be applied to virtually any sensor, whether in-situ or remote sensors, and whether it is mounted on a stationary or dynamic platform.

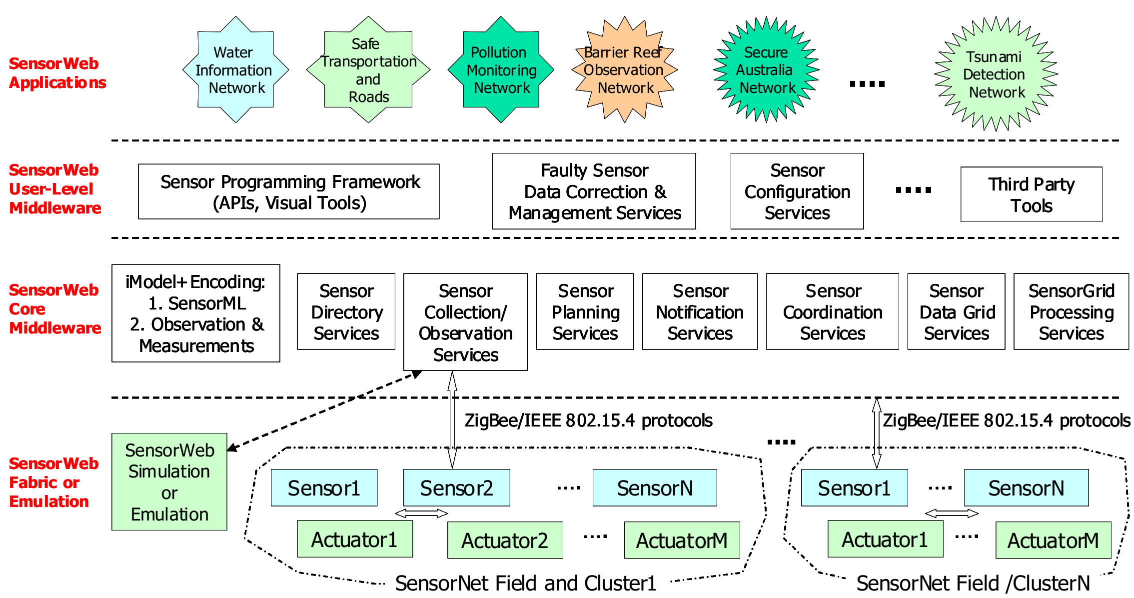

Fig. 3 – Open SensorWeb Architecture.

At NICTA/Melbourne University, there is an effort to develop a SensorML standard compliant software infrastructure for providing Web Services based access to and management of sensors. The project defines Open SensorWeb Architecture (OSWA) that provides a complete standards compliant platform for integration of sensor networks with emerging distributed computing platforms such as Grids. This integration brings out dual benefits: (i) sensor networks can off-load heavy processing activities to the Grid and (ii) Grid-based sensor applications can provide advance services for smart-sensing by deploying scenario-specific operators at runtime. The various components of OSWA are shown in Figure 3. Fundamental services are provided by lower-level components whereas components at higher-level provide tools for creation of applications and management of life-cycle of data captured through sensor networks.

The OSWA-based platform provides a number of sensor and actuation services, such as:

- sensor notification, collection and observation,
- data collection, aggregation and archiving,
- sensor coordination and data processing,
- faulty sensor data correction & management, and
- sensor configuration and directory services.

The project primarily aims to provide (a) an interactive development environment, (b) an open and standards-compliant SensorWeb application services middleware, and (c) a coordination language to support the development of sensor applications for various domains, including water observation networks, safe road transportation management systems, and Tsunami detection network for the early warning systems.

4.2 Interconnection and networking

The communications and networking situations in sensor networks and grid computing are worlds apart. In sensor networks, the emphasis is on low power wireless communications which unfortunately has limited bandwidth and time-varying channel characteristics, while in grid computing, high-speed optical network interconnects are the norm. Thus, communications protocols for sensor-grids will have to be designed take into account this wide disparity.

ZigBee has emerged as one of the first standards-based low power wireless communications technologies for sensor networks, and a machine-to-machine (M2M) interface between ZigBee and GPRS has recently been announced, thus enabling sensor networks to be connected to the cellular network infrastructure. One other promising development is low-rate Ultra-Wide Band (UWB) wireless technology which has characteristics suitable for sensor networks, i.e. extremely low power consumption, reasonable communication range, and likely integration with UWB-based positioning technology.

4.3 Coordinated QoS in large distributed system

The timeliness and correctness of computations have been studied extensively in the real-time systems community, while performance guarantees in terms of delay, loss, jitter and throughput in communication networks and have also been studied extensively by the networking research community. We shall refer to these as application-level and network-level QoS, respectively.

A number of QoS control mechanisms such as scheduling, admission control, buffer management and traffic regulation or shaping have been developed to achieve application-level and network-level QoS. However, all these QoS mechanisms usually relate to a particular attribute such as delay or loss, or operate at a particular router or server in the system. In order to bring about the desired system-level outcome such as meeting an end-to-end computational and communication delay requirement, these QoS mechanisms need to be coordinated instead of operating independently.

There are several methods to achieve coordinated QoS. For example, coordinated QoS can be viewed as a multi-agent Markov Decision Process (MDP) problem which can be solved using online stochastic optimal control techniques such as reinforcement learning (RL) [3] or neuro-dynamic programming (NDP). Tham *et al* [4] have shown that this technique can achieve end-to-end QoS in a multi-domain DiffServ network with multiple resource managers in a cost effective manner.

4.4 Robust and scalable distributed algorithms

In Section 3, we described implementations of distributed information fusion and distributed autonomous decision-making algorithms on sensor-grids. Generally, it is more difficult to guarantee the optimality, correctness and convergence properties of distributed algorithms compared to their centralized versions, although the distributed versions are usually more appealing from an implementation point of view.

Apart from distributed information fusion and decision-making, distributed hierarchical target-tracking [5], distributed control and distributed optimization are other current research efforts on distributed algorithms which are relevant to sensor-grid computing.

4.5 Efficient querying and data consistency

Another key area in sensor-grid computing is efficient querying of real-time information in sensor networks from grid applications and querying of grid databases by sensor network programs. It is expected that databases will be distributed and replicated at a number of places in the sensor-grid architecture to facilitate efficient storage and retrieval. Hence, the usual challenges of ensuring data consistency in distributed caches and databases would be present, with the added complexity of having to deal with a large amount of possibly redundant real-time data from sensor networks.

5. Conclusion

In this article, we have provided an overview of the potential and challenges in sensor-grid computing. The success of the sensor-grid computing approach will depend on the ability of the sensor network and grid computing research communities to work together to ensure compatibility in the techniques and algorithms that will be developed in the future, as well as the ability of sensor-grid computing technology to provide real value to users and applications in the various industries and application scenarios mentioned in this article.

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Grid Computing in Industry

Wolfgang Gentzsch[1]

For 10 years now, Grid computing has been the exclusive realm of researchers seeking to harness compute power for massive computational simulation challenges [1, 2]. However, recently, commercial enterprises too are beginning to focus on the tremendous business benefits that grid computing will yield. Yet it's still in an early stage of its evolution. "The Grid" has the potential to become a global web of ubiquitous electronic services which will improve infrastructure utilization, increase access and integration of huge amounts of data, enable new levels of communication and collaboration, and provide for the creation of new applications in e-science, e-business, and e-life.

A great grid example in the industry is the DAME project [3], a Distributed Aircraft Maintenance Environment for demonstrating the use of the grid to implement a distributed decision support system for deployment in maintenance applications and environments for aircraft engines, with Rolls Royce as one of the partners. Real-time processing of the huge amount of information coming from temperature and noise sensors from hundreds of thousands of aircraft engines can save lives and reduce down-time of aircrafts!

1. Grid Evolution from Research to Industry

Grid computing evolved from high-performance distributed computing in the 1990s. This evolution was driven primarily by the ever-growing need for computing resources; the availability of increasingly more powerful technology for networking, servers, middleware, and applications; and the development and widespread acceptance of the Internet and the World Wide Web. Today, as previously with the Internet and the Web, grid computing can be viewed as evolving in three waves: Research Wave, Business Wave, and Consumer Wave. Here, we will concentrate on the Business Wave.

Obviously, the Business Wave, or the second wave of grid computing, has already begun. Since about two years now, enterprise users and technology vendors are becoming aware of grid computing and its benefits for the enterprise (see next section). Awareness and interest are being driven by the growing number of successful grid projects in the global research community. In these research projects, benefits including remote access, improved resource utilization, collaboration in virtual organizations, and increased productivity have been clearly proven. Today, these benefits are demonstrated in thousands of grid-like production environments and intelligent clusters of resources (see e.g. use cases at [4]) distributed within enterprises all across the world – enabled by distributed resource management software including Load Sharing Facility (LSF, [5]), Portable Batch System (PBS, [6]), and Sun Grid Engine, [7] and [8], and on a more global level by Globus [x9], Avaki [10], Unicore [11], Gridbus [12], and the like. In addition, vendors including HP [13], IBM [14], Intel [15], Oracle [16], and Sun [17] have started grid projects which primarily focus on reducing cost and complexity in the enterprise datacenter, with initiatives such as the Adaptive Enterprise, Autonomous Computing and Computing on Demand, and N1. In April 2004, IT vendors such as EMC, Fujitsu, HP, Intel, Network Appliance, Oracle, and Sun, have taken another step towards developing enterprise grid solutions, by establishing the Enterprise Grid Alliance (EGA, [18]), a consortium of leading vendors and enterprises, with a pragmatic focus on the adoption and deployment of grid standards and technologies, including interoperability, for enterprise solutions. They just released the first version of enterprise grid reference architecture. In addition, the Globus Consortium [19] has been founded in January 2005, by HP, IBM, Intel, Sun, and Univa [20], to support business acceptance, productization, and implementation of the Globus Toolkit, with almost 40,000 downloads in 2004 the most widely used grid software in the world.

The aforementioned developments aimed at providing grid solutions for businesses, and involvement of mainstream technology vendors are strong indicators and evidence of this. In the next few years, we will certainly see a wide variety of

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efforts in industry to implement grid standards and interoperable technologies which will allow any company to conduct business, over a worldwide and often specialized and customized grid, in a user-friendly, reliable, efficient, and secure way.

2. Industry Benefits of Grid Technology

Often, in the past, in an enterprise, different departments have developed different market-specific solutions, each within their own home-grown departmental HPC environments. From an enterprise perspective, this IT infrastructure is very inefficient. An enterprise grid, on the other hand, offers economies of scale, access to one common HPC service for all departments, reliability and quality of service, reduced hardware and software costs, reduced operational cost, and increased productivity.

In most cases, an enterprise grid can be built out in two phases. The first phase is to optimize the resources that already exist within the departments. This phase may take a couple of weeks, and does not require any additional hardware. The next phase optimizes the overall enterprise environment through central management by adding central services, based on the concept of server consolidation.

Recent articles about grid computing benefits have primarily focused on better utilization of under-utilized computing resources. This alone often provides dramatic cost savings, but this is not the only benefit a grid can provide. Other important benefits of an enterprise or a research grid are:

- **Easy Access:** Seamless, transparent, remote, secure, even wireless access to computing, data, experiments, instruments, sensors, etc.
- **Resource Virtualization:** Access to compute and data services, not the servers themselves, without concern about the infrastructure.
- **On Demand Computing:** Access to the required resources, when they are needed most, at the required quality levels.
- **Resource Sharing:** Enables collaboration of (virtual) teams, across the enterprise or even over the Internet, to jointly work on a complex task or project.
- **Failover:** In case of system failure, applications can be migrated and restarted/continued automatically.
- **Heterogeneity:** In large and complex grids, resources are heterogeneous (platforms, operating systems, devices, software, etc.). Users can choose the best-suited system for their specific application, or the grid software will transparently choose the best suited and least loaded resource.
- **Resource Utilization:** Grids are known to increase average utilization from approximately 20% to 80% and more. For example, Sun Microsystems' internal Enterprise Grid, with currently more than 8,000 processors in three different locations (in San Jose, Austin and Burlington) to design next-generation processors, is utilized at over 95%, on average.

These elemental benefits translate into high-level value propositions which are especially interesting to upper management when considering whether to adopt and implement a grid architecture within the enterprise. These values or macro-level business benefits include, among others:

- **Enabling Innovation:** New capabilities, products, and services, driven by the ability to do things previously not possible.
- **Increasing Agility:** Shorter time to market, outpacing the competition, faster adapting to process or customer requirements.
- **Reducing Risk:** Improved quality and innovation, better business decisions, increased return on investment, and reduced total cost of ownership.

There are already thousands of enterprise grids around the world, in fields like drug discovery, genomics and proteomics, finance, software development, seismic analysis, automotive, aircraft, and other engineering applications, telecom, healthcare, and many more. Case studies about Caprion, Cognigen, Ford, GlobeXplorer, Inpharmatica, McLaren, Mentor Graphics, Motorola, Plexxicon, Petrobas, Rosetta, Sony, and Synopsys can be found at [21].

One example of a successful industrial global grid project mentioned already in our introduction is DAME (Distributed Aircraft Maintenance Environment, [3]), with Rolls Royce and partners from UK universities of York, Leads, Sheffield, and Oxford . DAME is an e-Science pilot project, demonstrating the use of grid technologies to implement a distributed decision support system for deployment in maintenance applications and environments. The on-line decision support system provides access to remote resources (experts, computing, knowledge bases etc), communication between key personnel and actors in the system, control of information flow and data quality, and the integration of data from diverse global sources within a strategic decision support system. Other examples of production grids may be found in [22].

3. Key Grid Initiatives in Industry

We briefly discuss key Grid or related technology development initiatives pursued by five leading IT companies: HP, IBM, Microsoft, Oracle, and Sun.

HP Adaptive Enterprise: The idea behind HP's Adaptive Enterprise [13] is the so-called Darwin Architecture. HP created this architecture to give enterprises a blueprint for building an adaptable IT environment. The Darwin Architecture starts with what customers already have in place and builds upward from there. It recognizes that each customer has unique needs and each is starting from a different foundation. HP consistently applies four principles to guide the design of an Adaptive Enterprise: simplification, standardization, modularity, and integration. Ultimately, becoming an Adaptive Enterprise is an evolutionary process. According to HP, one can start by establishing a more stable IT infrastructure, then work to become more efficient, then become adaptive by aligning key processes and synchronizing business and IT.

The Adaptive Enterprise provides a set of compelling benefits. An Adaptive Enterprise strategy moves your organization beyond the inflexible, complex IT architectures of the past to deliver more of what you need today—simplicity, agility and value.

IBM On Demand: For IBM, grid technology is the fundament for on demand business, [14]. Grid Computing brings together the appropriate services, software and hardware that helps to create a grid or expand an existing implementation. IBM has identified five key business areas which can benefit from grid: business analytics, engineering and design, enterprise optimization, government development, and research and development. In addition, IBM offers grid solutions for nine different industries: aerospace, agricultural chemicals, automotive, electronics, financial services, government, higher education, life sciences, and petroleum. The IBM Grid Toolbox, implements the OGSI standard and bundles the building blocks needed to enable the rapid deployment and integration of applications and processes in a standards-based grid. IBM also partners with grid software and services providers around the world, e.g. the Globus Alliance [9], Data Synapse [23], GridXpert [24], Platform Computing [25], United Devices [26], and a grid partner program [27].

Microsoft .NET: With the convergence of grid services with web services, Microsoft's .NET web services initiative, [28], too can be considered a valuable services architecture for building grids. .NET web services connect information, people, systems, and devices through software. Integrated across the Microsoft platform, .NET technology provides the ability to build, deploy, manage, and use connected, security-enhanced, grid-like solutions with Web services. .NET-connected solutions enable businesses to integrate their systems more rapidly and in a more agile manner and help them realize the promise of information anytime, anywhere, on any device. They help the business connect with its customers, partners, and employees, and enable the business to extend existing services to new customers. They help the business work more efficiently with its partners and suppliers. They unlock information so it can flow to every employee who needs it. And they reduce development time and expense for new projects. To foster convergence of grid services with the .NET platform, Microsoft collaborates with other companies and projects such as Gridbus Alchemi enterprise grid framework [29], GridIron XLR8 grid-enabling applications tool [30], SyncFusion and Excel-Grid [31], Xceed and .NET Data Grid Control [32].

Oracle 10g: Oracle's product strategy is led by the vision that grid computing could lead in the future. For Oracle, infrastructure resources managed in a grid will progress to the point that computing and storage capacity are delivered on demand like a utility. Applications in a grid will advance so that business and application logic are as massively connected and referenced as static web pages are on the Internet today, enabling frictionless, automated, global business between trading partners. Eventually, a global information grid will impart to every bit of digitally-represented information anywhere the same values one takes for granted with relational databases; it will be as if all information resides in a single virtual database. All inherent relationships between information will be revealed, and anyone with appropriate authorization will have instantaneous access to all relevant information regardless of representation, location, or access method. On the path toward this grid computing vision, companies need real solutions to support their incremental moves toward a more flexible and more productive IT architecture. The Oracle 10g family of software products, [16], implements much of the core grid technology to get companies started. And Oracle delivers this grid computing functionality in the context of holistic enterprise architecture, providing a robust security infrastructure, centralized management, intuitive, powerful development tools, and universal access. Oracle 10g includes: Oracle Database 10g; Oracle Application Server 10g; Oracle Enterprise Manager 10g; and Oracle Collaboration Suite 10g. On Oracle's website, [16], white papers exist describing each of these products and each of the main feature areas.

Sun N1 Grid: Sun started its grid initiatives in 2000 when it acquired Gridware and the Sun Grid Engine technology. Today, this distributed resource management software is installed in more than 10,000 department and enterprise grids. The further acquisition of Terraspring in 2002 and Centerrun in 2003, and their technologies for transforming network, compute, storage, and application elements into a single supply of resources, will enable companies to manage their IT resources more efficiently, simplifying the complexity of managing data centers and ultimately lowering operating costs. By unifying all of the resources in a compute fabric, the N1 Grid System, [17], will help enterprises to create massively scalable computing systems that also offer continuous availability. Key to this is enabling data center personnel to manage services at a higher level than is possible today—to create systems that offer a tighter, more direct alignment between servicing business needs and managing IT infrastructure and services. N1 Grid technology does this by creating a virtual system out of the underlying compute, network, and storage resources. In doing so, the N1 Grid System will reduce the system configuration and management burden on IT staff, help shrink costs, and increase the agility of enterprises that adopt it.

4. Case Study: MCNC Grid Computing & Networking Services

MCNC [34] in North Carolina is an independent, nonprofit, advanced technology research and service center that develops, tests, and deploys grid computing and advanced networking solutions in testbed environments and in production to serve education, research, government, and commercial organizations. In early 2002, MCNC helped create one of the country's first grids, the North Carolina Bioinformatics Grid testbed, [35]. MCNC is currently developing one of the nation's first statewide production grid services networks.

Since the mid-1980s, MCNC has operated the state's North Carolina Research & Education Network (NCREN, [36]), a production-level Internet Protocol network that interconnects over 180 research, education, government, and commercial locations in the state. This high-performance, high-speed communications and computing network serves as the backbone for future technology growth and is the foundation for North Carolina's statewide grid.

In 2001, MCNC and North Carolina universities, in partnership with Cisco Systems, IBM, and Sun Microsystems, launched the North Carolina BioGrid, [35] – one of the nation's first grid testbeds for life sciences research. This grid offers a reference platform for developing the high-performance computing, data storage, and networking resources needed for bioinformatics and cheminformatics applications. The testbed currently involves resources from the University of North Carolina at Chapel Hill, North Carolina State University, Duke University, and MCNC.

In 2003, MCNC launched its Enterprise Grid to address the needs of a broader range of scientific disciplines and to provide resources for the NC BioGrid and the statewide grid.

Through its research and development initiatives, MCNC together with the North Carolina higher education community is addressing the various challenges of deploying, operating, and scaling a grid infrastructure. Community research efforts include grid-based information retrieval systems, monitoring and tracking tools, joint collaboration in virtual environments, on-demand cluster partitioning, high performance network provisioning, and addressing security throughout the grid. Plans exist for building a commodity grid portal, the NC Startup Grid, [37], school grids [38], kids grids, gaming grids [39], a museum grid, a state-wide certificate authority architecture, and a grid appliance for MCNC's grid resource users.

5. Industry Challenges of Grid Computing

Grid computing is certainly still in its infancy, the phase of early adoption. Therefore, over the next few years, we will face (and have to solve) some technical, cultural, legal and regulatory challenges, [33]. Among them: it's difficult to differentiate reality from hype; therefore, building grids requires expertise which today is rare; sensitive data and sensitive applications (e.g. medical patient records) require strong security and security policies which have to be consistent and enforced across the grid; evaluating return on investment for such a complex technology; accounting, meaning who pays for what; lack of standards prevent interoperability of components; current IT cultures are not predisposed to sharing resources; not all applications are grid-ready or grid-enabled; open source is not equal open source (read the little print); what about liability and SLAs based on open source; "static" licensing models don't embrace grids; how to protect intellectual property; legal issues (FDA, HIPAA, multi-country grids); how can validated results be generated by un-validated systems (like for 21 CPR 11); and more.

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Dr. Wolfgang Gentzsch is currently Managing Director for Grid Computing and Networking Services at MCNC in North Carolina and an adjunct professor of Computer Science at Charlotte, Duke, and NCState universities. In 1990, he founded Genias GmbH (renamed to Gridware in 1998) which developed distributed resource management software for department and enterprise grids. In 2000, Sun Microsystems acquired Gridware and the Sun Grid Engine technology, and Wolfgang became Sun's senior director for grid computing. Wolfgang published numerous papers in the areas of mathematics, physics, and computer science and is member of a large number of conference and industry advisory boards.

National Conference on "IT for Defence-Force Multiplier"

Keynote Address by Dr. V S Arunachalam

Computer Society of India (Division-III) and Bangalore Chapter held a 3 day Conference on "IT for Defence – Force Multiplier" from 16-18, June 2005 at NIMHANS Convention Centre, Hosur Road, Bangalore.

Dr. V.S. Arunachalam former Scientific Advisor and Director General of DRDO, inaugurated the Conference and delivered the Key-Note Address on 16th June 2005.

The following is the brief summary of his Address.

He emphasized on the need to

- Put IT Potential in Defence to use.
- India should also concentrate on build up of "Secure Communication Networks".
- Internet has changed the definition of war and Defence.
- War Gaming and Simulation will help to face future Challenges. Stating that Information.

The Political leaders and policymakers are entitled to the benefits of research and knowledge that emerges from the defence science community. Dr. V.S. Arunachalam said Scientists should be serious on war gaming simulation that can forecast a situation that may arise 25 to 50 years from now.

Stating that information technology in defence had immense potential that should quickly be translated into policy and practice, he said this was because the Internet had changed the definition of war and defence rapidly. He likened this change in the way knowledge and information had become widely accessible, and "democratized and empowered" human Society to the 16th century arrival of the printing press. The printing press, not only released Europe from the tyranny of religion, also brought Newton and the wonders of physics that changed the world irrevocably.

New definition: Expanding on the theme of the new definition of defence, he said: "our Generals thought it would be a walkover in Sri Lanka, but it was not so."

Not an easy task: In games simulated by computers, several factors were fed to generate probable scenarios for the armed forces. "It is not going to be easy," he said.

But simulation helped in knowing "what steps should be taken in the next five years for the challenges that emerge in the next 30 years."

He said India should also work on building secure communication networks. "It is not just the role of the defence but also India IT firms which have to play a role in this."

This was because the Internet was useful and accessible, but vulnerable too. Application of the Internet in defence were still substitution-oriented, and this should change, because today, defence on the country was not merely strategy-making and preparing for the possibility of a nuclear war. India should be kept safe and defended against the onslaught of environmental disasters and debilitating phenomena such as greenhouse gases and climate change.

Knowledge power: Knowledge was defence, and with its power, the policymakers would be able to draw the blueprint of India's economic progress with sustainable development, he said.

The Conference was well attended by participants from Defence, DRDO, Industry, Academia and others. There were nearly 35 invited talks from Technology directors, Specialists and Industry. There were nearly 250 participants.

The Conference was really a unique one focusing on applications of Computers and IT for Defence. It was very well publicized in the media as well. It was highly appreciated by all present including the Sponsors.

Report by:

Dr. C.R. Chakravarthy, Event Convenor

Request from the Honorary Chief Editor

Computer Society of India has always been active in organizing National and International conferences all over the country.

Reputed professionals are invited to deliver the Inaugural and Keynote addresses. The insights shared by these professionals need to be documented and made available to our members at large.

The Event Chairman / Convenor is requested to send an authentic gist of such addresses to the Honorary Chief Editor on the first day of the conference. The style may be as indicated in this article. **It is best to get the gist from the speaker**.

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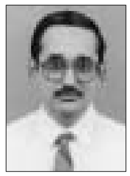

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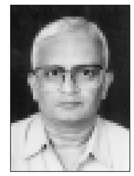

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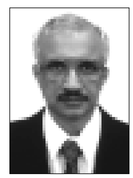

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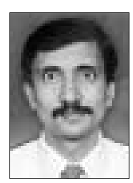

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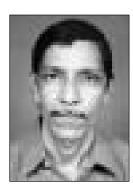

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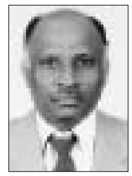

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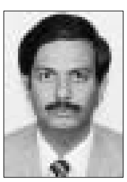

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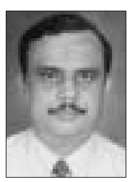

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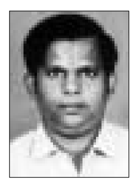

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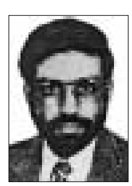

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CONMICRO 2005 - *A Report*

His Excellency Mr. T.V. Rajeswar, Governor of Uttar Pradesh inaugurated the two day National Conference of the Computer Society of India (CSI), Lucknow Chapter and CSI Division VIII 'CONMICRO 2005' at Hotel Taj Residency, Lucknow on 14th May 2005. The topic of the Conference "Current Trends in Computer Technology and Bioinformatics" was indeed a very relevant one especially at a time when India has emerged as a global superpower in software and there is an increasingly high and advanced usage of Information Technology in biology and biotechnology for the good of the mankind. Mr. Rajeswar stressed the need to spread computer knowledge from the school level upwards in the state.

H.E. Governor of U.P. Mr. T. V. Rajeswar lighting the lamp & inaugurating the Conmicro-2005 conference.

"Noida, Greater Noida and Ghaziabad have become a beehive of information technology and BPO", he pointed out while inaugurating the CONMICRO-2005. Mr. Rajeswar said that bioinformatics held a prominent place in the outsourcing of knowledge and business processes. He lauded IBM for its proposal for creation of an educational collaboration network and integrated education and health care systems for bringing about improvement in quality of life.

The Governor was of the opinion that through an integration of Computer Science, Information Technology and Biological Knowledge, Bioinformatics promises wonderful outcomes in the area of Food, Agriculture, Forestry, Healthcare, Pharmaceuticals and Environment. It was also stated that the ultimate goal of bioinformatics is to enable the discovery of new biological insights as well as to create a global perspective from which the discerning principles of biology can be discerned, eventually intended at improving the quality of life of the mankind.

The inaugural programme started with a welcome address by Dr. L.R. Yadav, Chairperson, CSI, Lucknow Chapter. This was followed by a profile of CSI activities presented by Mr. Lalit K. Sawhney, President-Elect, CSI. Mr. Sawhney said information technology was a force multiplier. India had taken a lead in IT and had added new dimensions to it. He added that e-learning was also a new emerging field. Mr. Sawhney said that CSI was committed to setting up of special group for bioinformatics. Global perspectives of Bioinformatics were presented by Dr. P.K. Seth, CEO, Biotech Park, Lucknow who was the keynote speaker. Dr. Seth said that Lucknow offers enormous opportunities for growth in the area of bioinformatics.. He said "The Biology Group in Lucknow is the strongest in country. You can find research going on in virtually every domain of biology and pharmacy field at scientific laboratories in Lucknow where drugs have been developed and its safety evaluated by top scientific institutions". Dr. R.K. Sharma, Chairperson, Programme Committee presented a Vote of Thanks at the inaugural function.

The first technical session on the theme "Bioinformatics:

Domain, Resources, & Trends" was chaired by Dr. O.P. Asthana, Sr. Scientist, CDRI, Lucknow which comprised many interesting papers. It included invited papers of Dr. Imran Siddiqui, Scientist, CDRI, Lucknow on the subject "Bioinformatics in Drug Development". Dr. Kamlakar Awasthi, Scientist, CDRI, Lucknow presented a paper on "Role of Arene interaction in Molecular Recognition". Dr. Ravi Shankar, Scientist, CDRI, Mr. V.Kumar, Mr. A. Jayaswal & Mr. A.K. Mishra also presented their papers.

The second technical session on Health Care, Pharma Industry, Agriculture & Forestry was chaired by Dr. Ashis Sen Gupta of ISI, Kolkata that had several paper presentations. It included the invited papers of Dr. Sanjay Batra, Scientist, CDRI on "Combinatorial Chemistry & Drug Design: Past, Present & Future". Dr. Sudhir Sinha, Sr. Asstt. Director presented his paper on "High Throughput Screening & Drug Development" and Dr. Ashish Arora, Scientist, CDRI presented his paper on "NMR in Drug Discovery". Mr. Iqbal Hasan of NIC also presented a paper on "Agriculture Sector and Fertilizer Informatics Network".

The final session of the first day on Bioinformatics: Analytical Tools and Environment was chaired by Dr Imran Siddiqi, Scientist, CDRI, Lucknow. It included the invited papers of Dr. Charu Sharma, Scientist, CDRI, Lucknow on "Microarray Technology in Drug Development", Dr. Ashis Sen Gupta, ISI, Kolkata on "Circadian Models and Analysis of Chrono-Therapeutic Data" and Dr. Manju Pandey, BHU, Varanasi on "Statistical Tools and Techniques for Bioinformatics".

On the second day, the fourth technical session on 'Software Engineering: Tools & Technologies' was chaired by Mr Jayant Krishna, Regional Manager, Tata Consultancy Services (TCS), Lucknow during which it was stated as to how software engineering brings a process rigour and quality focus in software development which gives a sustainable competitive advantage to the organisations. It included the invited papers of Prof. S.I. Ahson, DCS, JMI, New Delhi on "Computer Science and Bioinformatics" and Ms. Garima Singh, TCS, Lucknow on "Process Improvement Leverage to Enhance IT Capability: Model Based Process Improvement". Besides Mr. G.P. Singh of NIC Lucknow, Mr. S. Singh of MGKV, Varanasi, Mr. Ashesh K. Agarwal of NIC, Lucknow, Mr. T. Sakthivel, Mr. Kapil Agarwal of Banstali, Jaipur and Ms. Lakshmi Panat of PSPL, Pune also presented their papers.

The second session on e-Crime, e-Security, Patenting & Cyber Laws was chaired by Prof S I Ahson, Head, Computer Science, JMI, New Delhi in which Mr Vikram Singh, ADG, Police made an excellent presentation on E-crime. Mr. Amit Ghosh of TCS Lucknow presented a paper titled "IT Security – An Overview". The other speakers who presented their papers were Mr. Mizai

H.E. Governor of U.P. Mr. T.V. Rajeswar delivering the inaugural address at Conmicro-2005 conference. (L to R) Dr. L. R. Yadav, Mr. Lalit Sawhney, Dr. P.K. Seth & Dr. R.K. Sharma.

Lal of IAT, Pune, Mr. D.S. Guru of UM, Mysore and Mr. H. Arolkar of GLSICT, Ahmedabad.

The third session of the day on Communication, Netwoking, Database Technologies and Case Studies was chaired by Dr. Satya Singh of MG Kashi Vidyapith, Varanasi. Ms. Reena Dayal of TCS Lucknow presented a paper on 'Storage Networking : Need and Relevance'. Other speakers who presented papers were Mr. N. Rajendran of IDRBT, Hyderabad & Mr. Vatsal Asthana of DAVV, Indore. Two case studies were also presented in this session. These were presented by Dr. Y.K. Singh of NIC Lucknow and Mr. Amitabh Tiwari of TCS Lucknow.

The last session of the day was Vendor Presentation session. It was chaired by Mr. S.B. Singh, Sr. Technical Director & State Informatics Officer, NIC, UP. Two major vendors namely Microsoft & IBM apprised the audience about latest offerings.

The 2-day conference ended with a Panel Discussion in which several senior professionals from the region related to IT and bioinformatics participated. The topic was "Computer Technology & Bioinformatics: Role of Industry, Government, Academia and Research Institutes". Experts who spoke included Dr. D.S. Chauhan of UP Technical University, Mr. S.B. Singh of NIC, Mr. Jayant Krishna of TCS, Dr. Upendra Kumar of UPTEC, Mr. Asish Sen Gupta of ISI and Dr. A.N. Singh of RSAC. The experts agreed that a convergence of the mind among the industry, government, academia and research is almost like 'a writing on the wall' that will enable IT & bio-informatics to flourish at a faster pace and in a win-win mode.

The Two day conference was preceded by one day tutorial at Central Drug Research Institute, Lucknow, on May 13, 2005, in which 50 delegates participated. It included tutorials and demonstration of tools & labs to the participants.

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Computer Society of India

Membership Renewal Form

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Dues and fees

Due to the recent Amendments in CSI Byelaws, the Membership Year will be April to March. Hence durng the Transition period the membership year will be from 1st July, 2005 to 31st March 2006 i.e. for a period of 9 months. Hence those enrolling or renewing from 1st July 2005 will pay for 9 months as under:

Life Membership	Rs.	US$*
Age below 30 years	4250	720
Age 30 to 39 years	3750	620
Age 40 to 49 years	3000	520
Age 50 years and above	2250	320

Subscription / Renewal Fees

	July 05 to March 06	July 05 to March 07	July 05 to March 08	July 05 to March 09
Individual Membership	300	700	1000	—
Student Membership	150	250	400	550
Institution Membership	3750	—	—	—
Educational Institutions	2250	—	—	—

(10% rebate on life membership is allowed if he/she is a voting member for the previous ten years)

Note :

1. A student member should attach Bonafide Certificate from College Principal.
2. Members have the option to pay fees for 1,2 and 3 years and any increase in fees if effected after payment, will not be applicable till completion of that period
3. Life Membership fees can be paid either in one full installment or in two equal installments, the second installment to be paid within six months of the first or before 30th June whichever is earlier.
4. Please attach Xerox copy of your age proof for Life Membership .
5. Life Members can avail of photo ID card by paying Rs.100/- by DD along with 2 stamp size coloured photos.
6. **As an additional facility for payment of CSI membership fee for renewals and also for new membership enrolments, Computer Society of India has opened current account No 060010200003582 at UTI Bank, 264-265, Vaswani Chambers, Dr Annie Besant Road, Worli, Mumbai-400 025.**
7. **The CSI member concerned should deposit the appropriate amount of membership fee using the bank's paying-in-slip by correctly filling in all the details. Most importantly they have to mention the Membership No., Name, the above mentioned Current Account No. of CSI HQ and the Name of the Branch (Worli) on the basis of which reconcilation can be carried out.**
8. **The members should send the membership form alongwith photocopy of the paying-in-slip counterfoil containing bank's acknowledgement, to CSI HQ at Mumbai directly or through the local CSI Chapter. The branches of UTI Bank will transfer all such fees received from members to CSI HQ account directly**

National Seminar on

ELELTECH INDIA 2005

e-Learning and e-Learning Technologies

The Supercomputing People

CENTRE FOR DEVELOPMENT OF ADVANCED COMPUTING

A Scientific Society of Ministry of Communications & Information Technology, Government of India

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Recognizing the immense potential of the e-Learning Technologies, C-DAC Hyderabad and JNTU in association with Department of Information Technology, Government of India are organizing a 2-day National Seminar on "e-Learning and e-Learning Technologies (ELELTECH India-2005) during **August 8-9, 2005**.

This National Seminar is being organized with an objective to share the experience of Indian e-Learning community, including developers, implementers and users to as to enable us to plan a future strategies and road map in e-Learning for our country, keeping in view the issues of content, local languages, security, bandwidth, standards etc. The following are the focus areas of the seminar:

- Content Authoring and Authoring Tools in Local Languages
- Content Development Standards and Interoperability
- New and Inexpensive Technologies for Design and Deliver of Content
- Open Source Technologies & Open Source Courseware in e-Learning
- Collaborative Learning Grids
- Quality Assurance Methodologies in e-Learning
- Innovative Instructional Design Methods & Assessment Methods.
- eLearning for Physically Challenged
- Case Studies of e-Learning Projects
- Multimedia Content Delivery over Low Bandwidth

The Seminar will focus on various issues required to be addressed in implementing online learning tracks. It would also suggest the best possible solutions and the focus areas where we need to concentrate our energies. Focussed sessions will discuss – technology products, content, deployment methodologies, open source and open courseware, standards, quality assurance mechanisms, caring for multi-lingual and multi-cultural diversity, mobile learning, security issues, local issues.

An EXHIBITION featuring innovative solutions and valuable technologies for ICT based learning environments providing a golden opportunity to the organizations to display their e-Learning technologies, products, methodologies, courseware etc.

ELELCTECH INDIA 2005 will be of great interest to policy makers, managers,administrators, librarians, faculty, content developers, multi-media experts and learning community who want to – interact with technology experts; introduce and promote e-Learning in their institutions or organizations; develop e-Learning related skills; develop course material for e-Learning courses; and gain learning experience.

Registration: Interested participants and Exhibitors are required to register for the Seminar. Participants from academic institutions and government organizations are expected to pay Rs.2,500/- per person and participants from industry are required to pay Rs.4,000/- through DD/Cheque drawn on any Nationalised bank in favour of 'C-DAC, Hyderabad' payable at 'Hyderabad'. Outstation cheques will not be accepted. Registration fee should reach us by August 1, 2005. For more details please visit our website : www.cdac.in

Jointly Organized by
Centre for Development of Advanced Computing
DOEACC and JNT University, Hyderabad
in association with
Department of Information Technology
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http://www.cdac.in
email: eleltech@cdac.in

CSI Calendar 2005

November 2005

CSI - 2005 - 40th CSI National Convention

Theme : ICT for National Development

Date : 9-12 Nov 2005, Hyderabad

For details contact : Dr. Shaukat Mirza - csihyderabad@vsnl.net

Dr. K V Nori - kvnori@tcs.com

December 2005

ADCOM 2005 -

13th International Conference on Advanced Computing & Communications

Date : 14-17 Dec 2005

Venue : Amrita Vishwa Vidyapeetham, Coimbatore

For details contact : Prof B Jayaram- adcom2005@amrita.edu

P R Rangaswami

Vice President & Chair Conference Committee, CSI

Important HQ News

Have you renewed your membership for the year 2005-2006 ?

“If you have not sent in your Membership Subscription for 2005-2006. Please expedite so as to reach CSI HQ by 31st July, 2005. Please ensure that you send your subscription immediately by filling all the details in the renewal form published on page 40 of this issue

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Renewal Form on Page 40

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COMPUTER SOCIETY OF INDIA

From CSI Chapters

DEHRADUN

The Chapter organized a one day Seminar on "Emerging Computing Trends in IT" in the serene locale provided by Omkarananda Institute of Management and Technology. The Seminar was inaugurated by Swami Vishweshwaranandaji by lighting the Deepa and the Guru-Vandana.

Mr. P.K. Mittal, Chapter Chairman and General Manager, O.N.G.C. Dehradun, explained the usage of Information Technology in the Exploration & Production activities, networking and data base management in the company. He also explained how the specialists can take speedy decisions to find hydrocarbon resources with the help of seismic and wireline data available online . Five speakers presented their research papers in this seminar. Dr. R.M. Bhatt, Dept., Computer Science, Hemwati Nandan Bahuguna Garhwal University, Shrinagar, gave a talk on cyber crime, saying how people for just a few rupees are misusing this technology. Dr. Bhatt also described how cyber-criminals can break into the database of a bank. He said that many of the cyber-criminals in the world are children below sixteen years who unknowingly or out of curiosity do this type of work. He also gave some important tips to the students how to escape from cyber crimes and protect data from cyber criminals. Dr. Bhatt is also the Vice-Chairman of the Chapter.

Dr. T.C. Mohan, O.N.G.C. Dehradun, described some of the major steps that can be taken to ensure data security and also the capabilities of operating systems which can be exploited for this purpose. Dr (Smt.) H.B. Sharma, Chief Chemist, O.N.G.C. explained the usage of information technology in chemistry data management.

Mr. V.P. Singh, former Ambassador of India, emphasized on making more use of Hindi fonts in computers.

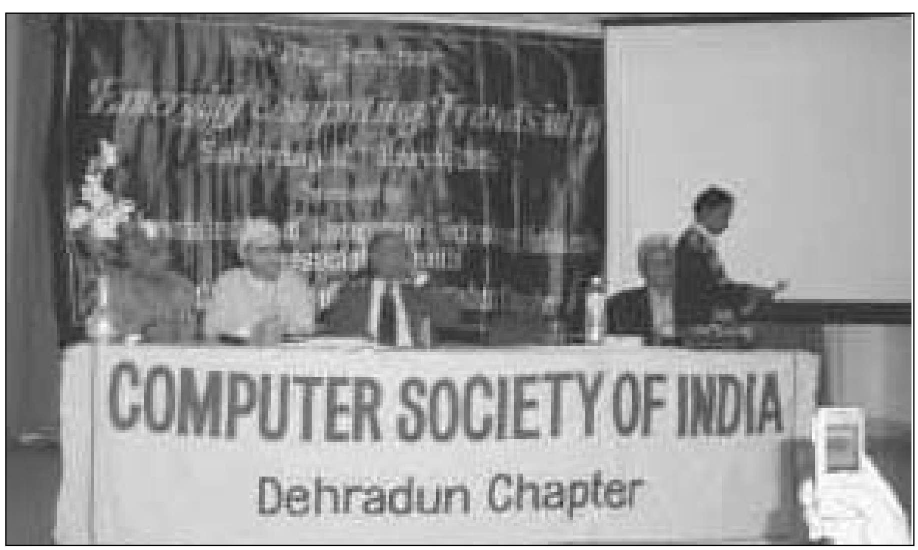
Mr Pramod Uniyal and Mr Vikram Kapoor of O.I.M.T. described a facility to users of Internet for the benefit of the common man.

While concluding the Seminar Swami Vishweshwaranandaji Maharaj of Omkaranand Ashram thanked all the guests and said that this kind of programmes can help students a lot in understanding the latest trends in IT, including threats and their counter measures.

More than 100 students from various institutes attended the Seminar.

PUNE

The Chapter started a yearly event "Insights", from last year. This year the event was organized on June 22. Half day tutorial on Software Testing and the panel discussions on different subjects like Infrastructure support for growth and sustenance of IT in Pune,



Dehradun : Inaugural function "Emerging Computing Trends in IT".

Pune : Mr Ajay Bhushan Pandey, IT Secretary Maharashtra State lighting the inaugural lamp at Insights-2005

Information and the Enterprise, Health Management for IT Pros, IT SMEs – How to manage challenges? and a presentation on Investigation of Cyber Crimes were the topics during the seminar. Ajay Bhushan Pandey, IT Secretary Maharashtra State, inaugurated the seminar where many prominent speakers participated.

The event was sponsored by SEED Infotech, Persistent Systems, Storability, Symphony Services and VeriSoft.

SURAT

On 7th May 2005, the Chapter organised an event on Power Infrastructure Management for Next Generation Data Centres and Network room by American Power Conversion(India) Ltd.

Despite revolutionary changes in IT technology and products over past decades, the design of power infrastructure for data centres network rooms has changed very little. Although IT equipment has always required electrical power, the way IT infrastructure has been deployed today has created new power related problem. In Presentation a systematic approach for nature and characteristics of next generation data centre and network room power system requirements were identified.

The Talk was delivered by Mr Rajesh Krishnan of American Power Conversion (India) Ltd and he presented InfraStruXure which is an on demand architecture for network critical physical Infrastructure (NCPI). There are four layers of availability as NCPI, Technology, Process and People. Each availability layer depends upon the layer below. He talked about InfraStruXure for Small, Medium and Large Data centres. He overviewed various power components, Rack, Cooling system, Management and service aspect for them

There were about 90 + Participants drawn mainly from Hazira belt

Surat : Students at " Hands on Experience with Red Hat Linux" industries like L&T, Reliance, Kribhco, Essar Information technology Ltd, ONGC etc. The other industries representative were drawn from Surat Municipal Corporation, Garden Vareli, Color tex ltd, Torrent Surat Electricity Company Ltd etc.

From 6th - 14th June, 2005 and 20th - 25th June, 2005 an event was organised on Hands on Experience with Red Hat Linux at Sarvajanik College of Engineering and Technology Surat.

The major course content of the workshop was Linux Installation, Networking with Linux, Configuring Peripherals and Terminal services, Samba Server, Apache Server, GNU, Linux Commands, Editors and Software Packages.

The work shop received an overwhelming response from the student's community in the south Gujarat region and over 160 students were trained in the open source ware of LINUX. The workshop was coordinated by Prof Mehul S Raval, Chapter Secretary.

VISAKHAPATNAM

The Chapter in association with Visakhapatnam Steel Plant, conducted national seminar on "**A**utomation & its **I**ntegration with **M**ES & **E**RP" **(AIME-2005)** in T&DC Auditorium, on 18th and 19th June, 2005.

During the Inaugural Programme on 18th June Mr K Ayyappa Naidu, Director (Personnel), VSP & Chief Guest of the function, released the souvenir brought out on the occasion and addressed the gathering. Mr ML Ravi, President, CSI & Guest of Honor, Mr KK Rao, Director (Operations), VSP & Chapter Chairman, Mr T. Lakshmi Narayana, Programme Committee Chair; & Mr GV Ramesh, Chapter Secretary, spoke on the occasion.

Vizag : Mr K Ayyappa Naidu, (2nd from Right) lighting the lamp on the occasion. (L-R) Mr KK Rao, Mr ML Ravi, President CSI, Mr D Kameswara Rao & Mr GV Ramesh of CSI-Vizag Chapter are seen.

Mr AV Sreenath, Enterprise Vertical, M/s WIPRO Technologies, in his keynote address elaborated on the Collaborative Manufacturing Enablers for seamlessly integrating the information from shop floor to Board room in an organization.

A total of 85 delegates representing VSP, RSP, DSP, BSP, HPCL, CPCL, NSTL, VPT, NTPC, Andhra University, Engineering colleges from Kakinada, Vijayawada, etc. participated in the seminar. The topics covered included automation systems, their integration with Manufacturing Execution Systems & ERP, Supply Chain Management, Relations Management, Implementation of ERP in industries, Embedded systems, etc.

Mr. PK Bishnoi, Director (Finance) – RINL-VSP & chief guest of the function, made a fitting case for cost-effectiveness of ERP systems in this competitive IT-era in his address.

Student Branches

NEC, KOVILPATTI

Inaugural and installation function of CSI students' Branch for the academic year 2005-2006 took place on 22nd June 2005 at National Engineering College, Kovilpatti. Mr.A.Murugan, Senior Engineer, Harman Beghar Automative Systems, Michigan State, USA,

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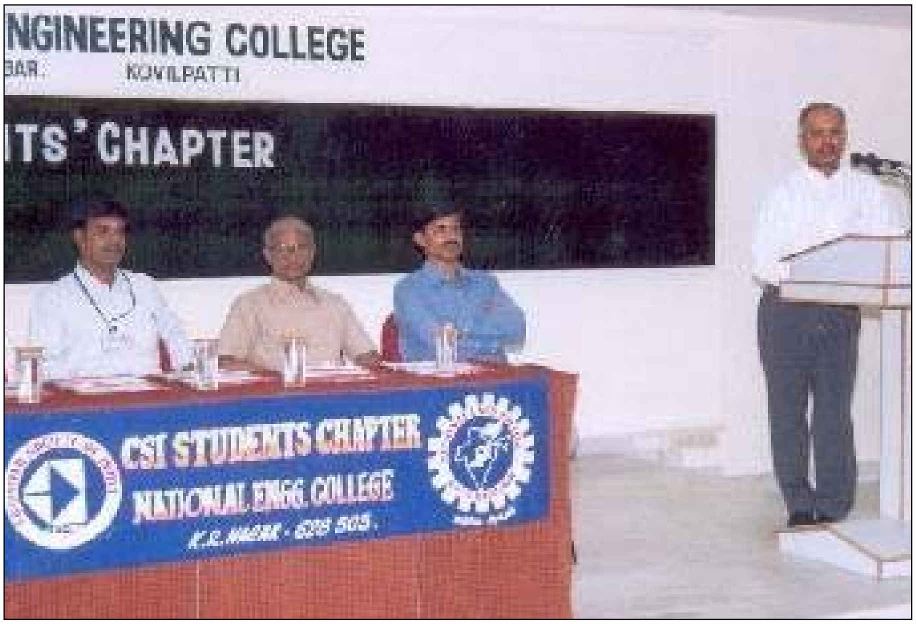

NEC, Kovilpatti : Mr.A.Murugan, Senior Engineer, Harman Beghar Automative Systems, Michigan State, USA, delivering Inaugural address

Dr.Chockalingam, Principal, and Dr. K.Ramar were present. About 40 faculty and 250 students attended the function.

Presidential address was delivered by the principal of the college. He encouraged the new team to work hard and win the best Student Branch award for this academic year. He advised the students to actively participate in the platform like CSI Students' Branch to develop their inner talents.

Mr.K.G.Srinivasagan, Student Counselor did the installation of office bearers of this academic year 2005-2006 and proposed the activities for the year.

Ms. J.Roselin, Lecturer of CSE &IT department delivered a special lecture to the students on the topic "Internet Security". She gave useful information to the students related to Internet and its Security.

MAM, TRICHY

The CSI Student branch along with ACES(Association of Computer Engineering Students)of Computer Science and Engineering department at M.A.M. College of Engineering organized a seminar on " Emerging Trends in IT", on 2nd July 2005. The Seminar was conducted by ELMAQ.edu, Chennai. Nearly 300 students of final and prefinal years actively participated in the seminar. Mr.Giridharan, Chief Excecutive Officer at ELMAQ.edu addressed the students on Current trends in IT and Skills required by the engineers to meet the IT industrial needs. Mr. Raghu, Technical Analyst, emphasized on the importance of learning Java & J2EE Technologies. The session was brought to an end with a project discussion.

On the same day, a seminar was conducted by Ms.N.Vijaya, Lect/ CSE department on "Networking Basics" for II year students. Sixty Five students actively participated in the seminar. The seminar focused on network concepts, types of networks and their importance.

❑❑❑

Mr Deepak Shikarpur (Centre) Seen with Ms Lila Poonawalla and Mr Ghanshyam Dass

Mr Deepak Shikarpur, Chairman Div III, CSI was installed as President of Rotary Club of Pune Shivajinagar on Monday June 27th.

Mr Ghanshyam Dass (Managing Director) NASDAQ Asia Pacific was the Chief Guest. Padmashree Mrs Lila Poonawalla Chairman Tetrapack group was also present on the occasion

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