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Practical Applications in Grid Computing

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Abstract: - Grid computing is an emerging concept which is driving the computing industry today. With the advent of a grid, computing will become a utility on tap just like water or power. Users in fields like business process re-engineering, accounting, finance and low cost non applied research, are ready to take advantage of grid computing. However going by the feedback of sample respondents, if grid computing is to be widely accepted, it still needs to overcome certain roadblocks both at technical level like security issues and at conceptual level like sharing of systems, considered personal till now. A feasibility study of installing a grid in a small community with wide bandwidth connectivity shows it to be a feasible and useful proposition.

Key-Words: - Grid computing, distributed computing, shared computer services, remote access, content sharing, grid security, grid applications, resource management

1 Introduction

A grid offers a simple, dependable and pervasive access across wide area networks and presents users with an integrated global resource. The grid infrastructure consists of computers (PCs, workstations, clusters, supercomputers, notebooks, mobile devices, PDs, handhelds and peripherals), software – (e.g.- application service providers renting expensive special purpose application software on demand), catalogued data and databases (e.g.- transparent access to genetic research database) and special devices (e.g. sensors, telescopes, satellite imagery)[1].

Grid computing aims at pooling of all kinds of IT resources and at presenting to a user a virtual metacomputer, which adapts to her changing needs. The user may be an individual or a businessperson, or a researcher . Grid computing infrastructure discovers the available compute-resources at a particular time and maps the demands for compute-resources from users to the available resources.

During the first few years of the twentieth century, every industrial and many household users of electricity installed their own generators. Though every generator was required to cater to the maximum demand, the actual use was rather limited. Moreover along with the generators, technical personnel, who would be able to run and maintain the systems, would be required. When the needs of a user increased, the older systems had to be replaced. The users stopped bothering about the availability of electrical power, only after electrical grids became ubiquitous. The users of computing facilities, at the start of the twenty first century, are in a state, similar to that of the users of electrical power at the start of the twentieth century. The major difference is the availability of Internet. The challenge today is to create a grid middleware, which makes the use of compute-facilities, maintained by service providers, as user-friendly as the electric power grids or telephone networks of today are. A grid would follow the utility model, enabling a user to get what she wants, when she wants it, not having to bother about infrastructure on an individual basis and having to pay for what she uses as reflected in her 'monthly bill' [12].

Grid computing may enable better utilization of existing heterogeneous IT resources, provide access to more computing power, enable improved service and access levels, reduce costs of computer usage and increase responsiveness, thereby enhancing both profitability and competitiveness [13].

The economic advantages of grid computing may arise from economies of scale and cost savings arising from reduction/ avoiding duplication of resources and components. The skimming and use of idle capacity will also contribute to lower costs. By using Beowulf clusters, it has been shown that high compute-power can be obtained by using relatively obsolescent compute-devices. By using similar techniques, a large number of smaller amounts of compute-power, if idle, can be harnessed to work together to provide powerful compute-capabilities to the user. In fact as the embedded devices become more powerful, in the future, one can envisage even chips in cars and washing machines doing 'grid duty' when idle.

In this paper, we present the results of two surveys related to the concept of grid computing. The first survey looked at a small community of 100 households, each having a wide band Internet connectivity. By using the available data, a conservative top-level design for a grid for the community has been completed, its costs have been worked out and the advantages it may provide to the community have been studied.

The second survey was for a mixed set of establishments, including households, service-businesses, manufacturing industries, government departments and educational institutions. The response from the Universities in the area was that they were having or joining a research grid of their own and they saw no merit in joining the survey for a general public grid at this stage. In spite of this negative response from the Universities in the area, the available responses provide a useful and interesting guideline of the directions that the grid research may take to make the global grid a reality.

Section 2 describes the problems of security that the grid users will have to face. Business processes can benefit greatly by using grids and it is brought out in section 3. Section 4 discusses the plans for a small community, wired through a wide-bandwidth network. The results of a survey on grid-readiness of a variety of organizations and households is presented in section 5. Section 6 concludes with a description of the roadblocks and the requirements for the grid to become a reality.

2 Information Security and Reliability:

Grid computing results in opening up the network/grid and providing access to data bases, applications and computing power. It is unlike the much simpler case of web-sites of today, which provide an access to information alone. The Global Grid Forum has therefore recommended that systems for authentication of both the user and the service provider and for authorization of access rights may be deployed.

Until the users feel confident about the security of data and IPR, they would not agree to join a grid. On the other hand the users may find that grids make their compute systems more robust and reliable. Grid computing will enable data to be stored and processed at remote or multiple locations on the grid, reducing the intensity of a threat, caused by a terrorist attack or a natural calamity. Passwords can be stored on the grid in truncated form and can be joined only at the instant of verification. The grid will also improve the capability of data recovery and ensure better continuity of the business of the organization, as destruction of even large parts of the grid will not make it collapse as long as islanding and bridging mechanisms are in place. This may lead to more reliable systems.

Using Internet, many organizations, which consider reliability in the face of any disaster to be of importance, have located the data bases at multiple locations, which are far apart. This does give the organizations a cost-effective method of recovery from a disaster. However unless each of the locations is able to have the full processing power required by all the activities of value to the business of the organization, it will not lead to an interruption-free service. A cost-effective solution, which can provide a reliable operation, even in the face of a disaster can be obtained only through a grid.

3 Management Processes and Business Process Re-engineering

The business processes of any large multi-location organization involve a large number of copies of processes, software and records across different offices. A grid will result in substantial cost savings and economy both in terms of minimizing the size of the database as well as reducing repetitive operations.

Similarly continuous management processes can be moved and run across different time zones and different regions by entrusting it to teams working in tandem. A large corporation can have only a couple of back offices that can service a large number of front offices across countries and regions.

With the availability of grid computing, each node and hence each employee would be empowered to deal directly with the customer/ client. The classic example of business process reengineering, involving IBM Computers, had shown the great advantage of decentralization and empowering of every employee, in his functional area. Grids will make the process even more effective.

Utilizing a grid may open up the following opportunities:

(i) Multiple data input / entry – data being provided by the client and captured at anytime and anywhere on the grid.
(ii) Data being processed transparently by users, irrespective of their location and time zones and irrespective of the amount of work load: This will

enable to put in place a mechanism akin to load balancing in management of human resources across the globe. This may economize the costs of running the applications.

(iv) Data can be provided to customers/ clients at multiple points and sites along the grid. The sites need not be fixed and can be moved depending on the requirements of the customer.

(v) An important benefit of grid computing would be the availability of high level of compute power to enable the use of sophisticated compute-intensive tools, like stochastic techniques and complex simulation models, to get the results in near real time, without investing in costly and under-utilized supercomputers. This can improve the quality of decision making and reduce the risks.

(vi) It is difficult to work out ROI for computing equipment 9 and for other facilities) required for applied as well as pure. High investment on permanent basis in computing resources may not be justifiable in such a scenario. Given the high rate of obsolescence and limited resale value, it is not possible to reverse an investment in computer infrastructure or hive it off without suffering heavy loss. At the same time without the backing of IT resources the research and analysis may not yield the desired results in the expected time frame.

The possibility of using idle compute-resources through a grid computing can provide the resources to researchers at a cost, which may make the research projects a feasible proposition.

If x be the number of potential discoveries, which are being studied by ‘y’ researchers, before the advent of grid computing, the cost of the effort may have been proportional to ‘x.y’. With grid computing, it becomes “x/y”. This may lead to faster discoveries at a much lower cost.

4 Essential Prerequisites

Before grids can be used effectively, certain essential or key prerequisites will have to be satisfied. These include interoperability of solutions, modifications of software to work on grids instead of standalone systems (sometimes involving considerable coding and expenditure), evolving certain common processes, guidelines, protocols, rules and regulations, do’s and don’ts and FAQ’s, modularity of data, uniform / closely matching standardized processes and formats, and so on. These are mostly technical issues. The more intractable issue may turn out to be cultural, social, political and economic integration access the grid.

These issues therefore need a careful consideration and need to be addressed and sorted out to make grid computing popular, successful and acceptable in the long run.

A universal grid will accentuate the insecurities, which some groups have started feeling with the spread of the Internet, probably leading these groups to come to terms with the wider world. The world-wide Internet is playing a major role in moving the humanity in the direction of a common moral code. It is making it difficult for local satraps to continue with the age-old or local codes of conduct, which have permitted them to ride rough-shod over the rights of individuals. A universal grid, which becomes essential for competitive strength, may make it impossible for the local satraps to control inter-actions through the intelligent and active highways.

5 Feasibility of a Grid for a Small Community

Grid researchers have started the development of schedulers and resource management systems, which can provide resource marshalling and load balancing on the grid [6]. Globus Tool-kit [5], Legion [9], Condor-G [10] and WebDedip [7] are examples of grid tools available today. Research on grid schedulers is an active area of work today [8] and [11]. Another important area of research is the security issues in grids [14 to 17]. Most of the work is available as freeware and it may make grid computing a feasible proposition for even small communities.

A survey was conducted in a small community of 300 households in Mumbai, India. Each house in the community is wired by a cable connection and has a continuous internet connectivity of wide bandwidths. Initial capital cost of wiring the community was US Dollars 3,500 (one time capital cost). The monthly maintenance cost per household was US Dollars 9.

The present computational cost and the minimum configuration of the computer system in each household is as follows:-

Standard PC used by each household.

RAM 128 MB, storage 40GB to 80GB, processing speed – P IV with printer, excluding scanner. The cost is US Dollars 900. The computer is used fairly intensively in the evenings and early mornings in most of the households. However there is a wide variation, depending probably upon the employment pattern of the persons in each household. The time for which the computer is used is called the work-time of the computer for the household. The computer is used about 60% of the work-time to access the internet, 30% of the work-time for games and about 10% of the work-time for applications like word processing etc.

The total cost for 300 households would be US Dollars 270,000.

DEVELOPMENT OF AN INTRA-GRID FOR THE COMMUNITY: With the above facility, a study on the possibility of creating a grid for the community has been studied. The grid may be able to provide the facility of a meta-computer with huge computing power to every household.

"A recent Hewlett-Packard study found most corporate servers use just 10 to 35 percent of their processing power. IBM estimates average desktop-capacity-utilization rates of just 5 percent." [2]

Since in this survey, the amount of time for which the household machines are idle, is not known, it may be assumed that for 50% of the time, the machines are unused.

We may assume the MFlop rating for a Pentium 4 CPU to be 1000 MFlops. This is a very conservative estimate since the SiSoft Sandra 2002 benchmark rating for a 2.4 MHz Pentium with 256 MB of main memory and 30 GB of hard disk is 2686 MFlops [3].

For 50% of time, at a very conservative estimate, a spare compute-power of 300 GFlops can become available to the 300 households. This may be compared with 850.6 GFlop rating achieved by the SBC Supercomputer in November 2004[4]. The comparison is not exact but only indicative because whereas the Top 500 computers uses Linpack benchmark, the benchmark commonly used for PCs is SiSoft Sandra.

If the grid is to be created by using the idle cycles of the 300 households, the challenge is to have middleware, which makes the idle compute-power available at a negligible overhead.

In fact new users and those, with less use for gaming applications, can go in for thin client nodes costing about US Dollars 250 once a minimum critical size of the grid (say 1000) supporting different applications is reached. Many of the gaming applications require intensive computational power. So users, who have to use their machines continuously for gaming may be able to derive the full compute-power from the grid, only when the community of users becomes larger and thereby more diverse. At present, the survey of the 100 households suggests that in the evenings, for a couple of hours, about 80% of the machines are busy. So the compute power available during those hours will fall to about 20% from the conservatively computed average of 50%.

6. A Survey of Potential grid Users

An analysis of the usage of computing resources and the behavior pattern of organizations and individuals using computers shows, that peak resource needs arise only for short durations like when "running a formula / analysis, scanning an image, extracting a trial balance, running a simulator, playing a game", etc. The use of grid computing can make it possible for organizations to make do with minimal captive computing resources and tap computing power off the grid for a major part of their needs.

A grid, to which any user in any area may be able to tap in, does not exist. But many organizations have built intra-grids for their internal use. Thus Bayer was able to save millions of dollars by creating a grid, served by two data centers only. The earlier Bayer system had 42 data centers in USA. A telecommunication company in Germany has built an intra-grid from which its units can tap the compute-power they need by paying for it.

The authors addressed a questionnaire on grid computing to respondents in and around Mumbai, the financial and business capital of India. The summarized results of responses to this questionnaire have thrown up interesting results regarding usage of computers and the attitude, readiness and issues facing grid computing in this part of the world.

The average age in terms of number of years since establishment of the respondent entities was 20 years. The sample was equally divided between private companies, government/public sector entities, individuals and others.

The type of activities and business trend included finance, consultancy, manufacturing and others.

Forty responses were received back. Around 50% of the respondents regularly used computers, 25% were occasional users and 25% used it almost always very often. The number of computers showed a majority, 50%, having 5 to 10 computers, around 45% had up to 2 computers and only 5% having more than 20 computers.

Majority of the PCs were Pentium IVs (50%), around 35% were Pentium IIIs, only 10% were 386 and 5% others. The average investment per computer was US Dollars 450 with a hard disk size of 80GB and RAM size ranging from 32 MB to

256 MB. The operating system commonly used is windows (60%), followed by UNIX 25% and Linux around 15%.

Application software was mostly purchased, branded being 50% and unbranded 25%. Self developed software was used by only around 25% respondents.

The average investment in application software was US Dollars 1,100.

Internet Connection was available to almost all respondents with 50% having it both at home as well as at place of work, and 25% each having it only at home or at work.

Only 25% respondents had a website as against 75% who did not have one. Not many of the respondents used the web-site for e-commerce applications. The web-sites are used mainly for contact and for providing information.

The computer systems were used for only up to 2 hours a day by 25% respondents, between 7 to 8 hours a day by 50% and up to 12 hours a day by 25% respondents. Out of the actual usage only about 15% to 25% time was for intensive computing and up to 5% each for scanning and running applications requiring heavy use of computing power like games. For individuals, the use of computers for games was as high as 50% of computer usage time, though total usage in such cases was less than 2 hours. The computer was idle on an average for 12 to 16 hours. The peak capacity usage was for 25% of the time with minimum usage being reported for 50% of the time.

Respondents used email up to 70% for work and interaction and only up to 30% for personal communications. Internet at business was used primarily for work rather than for entertainment.

All respondents had printers mostly inkjets and laser jets, whereas only 25% each had scanners and web cameras.

The usages of computers as indicated in order of preference as per responses of respondents are as follows:

1) to store customer data/records
2) for billing and office administration
3) to write instructions, issue bills and receipts,
4) for communication with remote clients/employees as well as for awareness and information dissemination
5) to store business/market information
6) as an alternative source of information for decision making and for decision support.
7) For training, education and market research
8) For follow up of customers
9) For office purposes

Regarding networking 25% were standalone, 15% had two computers connected to each other, and 50% were part of an internal network and only 10% were part of a wider/bigger extranet.

Up to 45% respondents were willing to share computer resources and computer time with others, while a majority of 55% were not ready to do so. This indicates a general lack of confidence in the security of networks and grids.

Up to 65% were actually comfortable storing the data on a remote computer on a grid, provided security and confidentiality was maintained. This seems to be a direct result of the popularity of browser based free email services having up to 2GB of storage space coming free with it.

Interestingly when it came to storage of personal information as against data, the percentage fell from 65% to only 45% agreeing to such storage on computers on the grid.

The fear of compromise of personal information can be judged by the overwhelming majority of respondents-75%, being afraid of information leakage and up to 75%, not willing to share personal information with companies using grid computing.

That grid computing, especially in terms of acceptability, has a long way to go, is evident from the fact that 100% of the respondents were more comfortable with using standalone computers rather than computers on a grid.

This again is probably the fallout of how PCs were introduced in the first place. The full form of PCs is “personal computer” and generally you do not share something that is personal so easily/readily.

If grid computing is to be popular we have to move away from the concept of a computer being something personal to something which is to be shared like probably a telephone, or a water faucet or an electricity (power) point/plug point.

25% of respondents preferred to pay for computer usage on ‘hire basis’ for actual usage with an additional 25% were ready to go with the hired model if adequate security is built in. But a majority 50% preferred to own and use their own computers.

However as against this, a majority of 50% respondents preferred plug-and-play anywhere-access with an additional 25% pitching in for anywhere-access with adequate security. Only 25% stuck to personal private systems.

Respondents generally agreed/opined that awareness needs to be created among users who are not sensitized and a national infrastructure in the form of a supportable grid for networking computers with full connectivity at affordable rates, needs to be created by the government.

About 25% of the respondents were more concerned with issues like quick accessibility and availability of resources on the grid and system security. A high percentage of respondents (50%) had no comments or suggestions to offer, indicating a low level of awareness.

This survey on grid computing, though done on a relatively small base of less than 50 respondents, is significant in terms of some of the revealing findings. These inputs if rightly used will go a long way in promoting the concept of grid computing..

7 Conclusion

What then are the roadblocks to the utopian world of grid computing where you can plug in anywhere, in the house, on the street, in the car ….and get computing power and access to databases and applications?

Apart from the issues of security, and technical problems of grid failures and overload of the grid, the cultural and ethical issues may come to the fore.

There is also the need to identify as to who will provide the network, the connectivity and the base compute-power of the grid? Is it the State/ Federal Govt. that has to come forward and develop this infrastructure like roads, bridges and power lines were done in the past?

We have shown in the paper that small communities and organizations, including businesses and government services can benefit in terms of more reliable service at lower costs. However development of a reliable and user-friendly grid middleware and elimination of the administrative roadblocks is a necessity before the global grid can become a reality.

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