Exploiting Communication Framework To Increase Usage Of SMIG Model Among Users

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***Abstract*— Today is the era of parallel and distributed computing models. Recent developments in DSM, Grids and DSM based Grids focus on high end computations of parallelized applications. We have built SMIG (Shared Memory Integrated with Grid) which amalgamates DSM and Grid computing paradigms as a part of our doctoral work. Literature citations have indicated a lacuna in how technological models are communicated to potential users to increase usage. Based on this lacuna we have identified the potential users and prepared a communication framework to disseminate SMIG information in order increase its usage. Hence in this paper we have compared various communication techniques used for disseminating DSM, Grid and DSM based Grid models as surveyed from literature. We have further designed and implemented a communication framework to percolate SMIG information to users. In the communication framework we have plugged in various tools for information dissemination and feedback (apart from those found in the survey) for promoting usage of technology among volunteers and application developers. These are included in the communication framework, namely arranging overview sessions, passing written documentation like presentations, installation handbook, FAQs, and also providing an opportunity to use SMIG model. The detailed responses received from the users after implementing the communication framework are encouraging and indicates that such a communication framework can be used for disseminating other technology developments to potential users. This will prove useful in today's dynamic world where technological developments are happening on a day to day basis.**

Keywords- DSM based Grid;Shared Memory integrated Grid-SMIG;Communication Framework.

I. INTRODUCTION

With increasing advances in semiconductor integration and network technologies computer costs are decreasing and usage of computers is rapidly seeping in every day applications. Supercomputers are slowly being replaced with multiprocessor architectures which can perform similar functions at lesser costs. Two computing paradigms have emerged: parallel computing and grid computing. In the past several decades two parallel computing systems are widely used namely loosely coupled and tightly coupled systems. Both these system have their advantages and disadvantages. Distributed Shared Memory (DSM) [1, 2] exploits the advantages of both models: ease of programming of tightly coupled systems (shared memory) and scalability of loosely coupled systems (distributed memory). DSM enables each processor to have its own physical memory but all processors together display a logical abstraction of memory address space. DSM systems can be built in hardware (called Hardware DSM -HDSM) or in software (called Software DSM-SDSM) but they are dedicated completely for distributed computing applications.

Currently computers be it standalone, in LANs or in WANs may execute some high-end tasks and use 100% CPU power but not continuously. Grid computing exploits these underutilized resources for high performance computing where the high-end computations are parallelized and distributed among machines for faster execution [3,4]. It is possible to combine SDSM and grid computing paradigms and build an amalgamated model which shall have benefits of both, carry out high end computations, easy of program, scalable and exploit underutilized resources. We have built SMIG (Shared Memory Integrated with Grid) model as a part of our doctoral work. In the literature surveyed it was noticed that almost all SDSM, Grid and DSM based Grids have been developed in academic research environments. However there was a limitation in how information about these models was communicated to potential users. Hence it was felt that just building an SDSM Grid amalgamated model was not enough but it was also important to identify the potential users, design and implement a communication framework to broaden the usage of this model.

In this paper we have described the design and implementation of a Communication Framework to broaden usage of SMIG model among users. The paper is structured as follows: In section 2 we set the context with a brief idea about the background to current computing paradigms followed by an overview of SMIG model in the next section. The motivation for SMIG communication framework and the plan for communicating the same to potential users is put forth in section 4 and 5 respectively. The sections 6 and 7 give the details of the implementation methodology and discussion of the results. Finally we end the paper with conclusion and scope for further research.

II. MOTIVATION

Today there is an inherent rise in usage of computers and development of software programs, algorithms and applications. Standalone machines do not provide satisfying response to large sized programs and high end computations. Two trends cater to the need for high performance computing namely: Distributed Shared Memory –DSM and Grid

Computing. They have the advantages of optimization of memory and computing power respectively. DSM provides an abstraction of a single virtual memory although the memories are physically distributed across machines while grid computing computes through sharing of existing idle/ underutilized resources. Both these paradigms provide an efficient replacement for supercomputers. Parallel programs exhibit speed up and improve performance in a DSM environment but it uses dedicated computers, example DSM systems are Treadmarks, JUMP etc. [5,6] Grid computing optimizes existing unused computational power and is useful for parallel programs which can run independently, example EU Data Grid, NASA grid, BOINC, SLINC, SETI etc.[7,8] Both computing paradigms reduce hardware requirements and lower the installation and implementation costs. High-end computations can be easily parallelized and distributed in both DSM and grid based clustered computers to speed up execution and thus optimize the use of existing resources. There are research citations: SMG and Teamster-G which indicate that DSM based grid is a viable option to explore. SMG [9] explores the environment of OpenMP and is compatible with DSM System layered on top of Message Passing Interface (MPI) and together they can execute in a grid environment. Teamster-G is a grid enabled DSM simplifies the programming on computational grids and enriches the applications of grid computing [10]. Based on this motivation we have designed and developed SMIG model by amalgamating SDSM and Grids, namely JUMP DSM (JIAJIA Using Migrating Protocol and of working principles of SLINC (Simple Light Weight Infrastructure of Network Computing. The SMIG model is released as an open source package.

III. DETAILS OF SMIG MODEL

SMIG comprises of a interconnected homogeneous machines with the configuration of one Master and other Hosts. SMIG uses special calls for initialization/ finalization, memory allocation and synchronization (JUMP code) which are handled by SMIG Master. The hosts are volunteers who have donated their machines for application execution which will execute in the background. SMIG Master initiates various DSM calls: initializes the DSM abstraction, configures hosts and allocates memory on all hosts. It then initiates application processes to be executed on all the hosts. Java script is executed on hosts to call this application processes and execute them in low priority. The application process is initiated. On every local machine host OS (Operating System) schedules jobs. The application is run on low priority giving preference to the volunteer's tasks. Based on the amount of computing power available on the hosts the application processes complete execution and the results are returned to the Master. SMIG execution is illustrated in figure 1.

Once SMIG was installed, the applications (Matrix Multiplication/ Merge Sort/ Bucket Sort) for 2/4/8 hosts and a specific data size were executed. The applications were run on SMIG. It was observed that SMIG model is feasible and that all applications completed execution. However the time required for application execution on SMIG(N) was more than that on SMIG(0) with volunteers also using the hosts for their own application execution survey was carried out to understand the communication techniques used by DSM, grid and DSM based grid researchers for information dissemination to users.

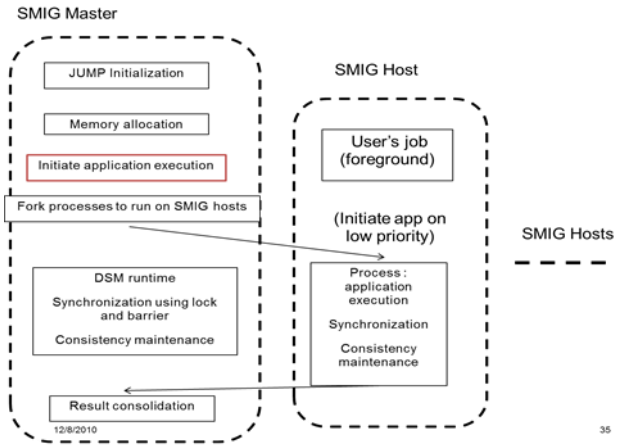

Figure 1: SMIG execution

Researchers have communicated DSM and Grid models to computer users in different ways (through web by published papers, by distributing source code, help manuals, tutorials etc.) and to different types and number of users. Many of the efforts spent in communication have not helped to boost usage of these models, or encourage research in improving performance or modifying existing systems barring a few.

IV. NEED FOR SMIG COMMUNICATION FRAMEWORK

Literature citations have highlighted various tools used for disseminating information [11, 12, 13]. Communication of information increases usage of a technical model, and leads to further research and enhancements in that area. This in turn results in evolution of new models. Extensive survey was carried out to understand the communication techniques used by DSM, grid and DSM based grid researchers for information dissemination to users. Researchers have communicated DSM and Grid models to computer users in different ways (through web by published papers, by distributing source code, help manuals, tutorials etc.) and to different types and number of users.

Many of the efforts spent in communication have not helped to boost usage of these models, or encourage research in improving performance or modifying existing systems barring a few.

This comparison of techniques used by DSM, is listed in table 1, used by grids is listed in table 2 and that used by DSM based grids is listed in table 3.

TABLE I. COMPARISON OF MODES OF COMMUNICATION OF DSM

Title	System type	Research papers	Technical information availability on the web			
			Source code	Documentation	Promotion techniques	Others
JUMP DSM	Model	Yes	Yes	Yes	Nil	Nil
Teamster	Model	Yes	Nil	Nil	Nil	Nil

TABLE II. COMPARISON OF MODES OF COMMUNICATION OF GRIDS

Title	System type	Research papers	Technical information availability on the web			
			Source code	Documentation	Promotion techniques	Others
OptorSim	Simulator	Yes	Yes	Yes	Posters	Nil
GridSim	Simulator	Yes	Yes	Yes	Nil	Nil
Globus toolkit [10]	Grid building toolkit	Yes	Yes	Yes	Nil	Online support, newer versions.
BOINC	Model	Yes	Yes	Yes	Nil	Tutorials , online community
SLINC	Model	Yes	Yes	Yes	Nil	Peer review for usability
EU Data Grid (European Union)	Consortium of academic institutes	Yes	Yes	Yes	Posters, handouts, demonstrations	Online forum, community

TABLE III. COMPARISON OF MODES OF COMMUNICATION OF DSM BASED GRIDS

Title	System type	Research papers	Technical information availability on the web			
			Source code	Documentation	Promotion techniques	Others
SMG (Shared Memory Grid)	Model	Yes	Nil	Nil	Nil	Nil
Teamster-G	Model	Yes	Nil	Nil	Nil	Nil

As an example JUMP DSM source code and documentation are made available on the web. The JUMP documentation was sufficient to install and execute applications and no additional help was required during this activity.

The user manual also provided steps for writing our own application program. JUMP installation guide includes pre requisites, installation steps, executing application programs, how to write applications for JUMP and the application programming interface.

Few communication tools have been used for DSM and Grids. However no details were available for communication of DSM based Grid on the web apart from one or two published papers. Building a model is not enough, concrete steps need to be taken to communicate the model.

V. SMIG COMMUNICATION PLAN

We have proposed a communication framework to propagate the technology related information to potential users. The users were classified as volunteers who donate resources to SMIG for application execution, and developers who can use SMIG for running high end computations. The objective for volunteers was to create awareness of SMIG among users and enable them to recommend volunteering on SMIG to others.

The goal of communicating to application developers was to create awareness of technical information and how high end computations can be executed on SMIG and enable them to promote SMIG for high end computations. Various information dissemination and feedback tools have been identified as listed in table 4 and table 5 for information dissemination and feedback respectively. The above tools form the basic building blocks of SMIG communication framework.

TABLE IV. TOOLS FOR INFORMATION DISSEMINATION

Tool	Mode	Comment
Presentation	Lecture	Was different for volunteers and Application developer
Interactive discussion	Oral	Audience participation to clarify doubts
FAQ	Written	Create more awareness of SMIG
Installation handbook	Written	Only for application developer Gives overview of the installation procedure Gives overview of application development
Experiment SMIG usage	Hands on practice on SMIG	For volunteers: to understand how SMIG works and how SMIG does not slow down user's tasks For application developers to understand how SMIG is used for high end computations

TABLE V. FEEDBACK TECHNIQUES

Techniques	Mode	Comment
Pre SMIG questionnaire	Written through email	For both Volunteers and Application developers
Post CF (Communication Framework) questionnaire	Written through email	Different for Volunteers and Application developers

Observation Report	Non verbal, written in observation report	Different for Volunteers and Application developers

VI. IMPLEMENTATION PLAN

The communication framework was built using the above information dissemination and feedback tools. The documents were prepared and later specific information was disseminated to users: volunteers and application developers.

TABLE VI. CRITERIA FOR SELECTING V AND AD

No.	Criteria	Volunteer		Application developer	
		EG(V)	CG(V)	EG(AD)	CG(AD)
1	Experience	0-1.5 years	0-1.5 years	1.5-3 years	1.5-3 years
2	Competency	Computer users/ Basic programming	Computer users/ Basic programming	Computer programmers	Computer programmers
3	Working hours	General / morning shift	Any shift	General / morning shift	Any shift
4	Project phase	Design/ coding	Any except Go Live	Design/ Coding / Testing	Any except Go Live
5	Location	Mumbai / getting transferred to Mumbai	Any location	Mumbai / getting transferred to Mumbai	Any location

Pre SMIG Survey Questionnaire was given to the entire study group to get information about the computer usage in terms of time for which used, platform of working and were they aware of their average CPU power and memory usage. The other information gathered from the survey was whether they were aware of the concept of volunteering, background processing, and of SETI and UD (United Devices, here onwards called as UD) on the Internet. \Lastly two additional questions were included in the survey to find out whether they have volunteered earlier and would they be willing to donate their CPU cycles. The Post CF survey was conducted after SMIG information dissemination (Lecture, distribution of FAQ, and SMIG usage) to volunteers.

The post CF survey was conducted after SMIG information (Lecture, distribution of FAQ, and installation handbook and SMIG usage) to application developers. This survey was designed with the objective of gauging the feedback of the treatment of the communication framework components on Volunteers and Application developer's experimental groups. The questions related to the presentation are listed in table 7. The interactive discussion and SMIG usage was closely observed for both volunteers and application developers and the implementation details have been summarized in table 8.

TABLE VII. POST CF INFORMATION

Question related to	Details from Volunteer regarding	Details from Application developer regarding
Presentation	Quality, message of volunteering and SMIG overview, provided inspiration for volunteering	Quality, message of volunteering and SMIG technical overview, resource optimization and parallelization of high end applications, provided inspiration for volunteering, using SMIG for application execution and promote to others
FAQ	Quality	Quality
Installation handbook	Not applicable	Quality, installation understood
SMIG usage	Types of tasks were executed on SMIG as volunteers, whether the responder realized that SMIG was running in the background.	Types of tasks were executed on SMIG as volunteers, whether the responder realized that SMIG was running in the background.
Post communication framework	Inspired for volunteering and recommending to others for volunteering	Inspired for volunteering and recommending to others for volunteering, using for high end applications and promoting to others
Communication framework component	Which was responsible to inspiring and recommending volunteering (presentation, FAQ, SMIG usage)	Which was responsible to inspiring and recommending to others (presentation, FAQ, installation handbook,SMIG use)

TABLE VIII. INSTRUMENT: INTERACTIVE DISCUSSION / SMIG USAGE

Atmosphere	Communication details	Monitoring	Observation comments	Summary
Environment , site, group constitution, body language	Event, objective, mode, procedure of the event	How was the event monitored	Comments regarding the response of the attendees to the conduct event and their participation	Impact of the event on the participants, relate to dependent variables

The communication framework implementation for experimental group of both volunteers-EG(V) and application developers-EG(AD) are illustrated in figure 5.

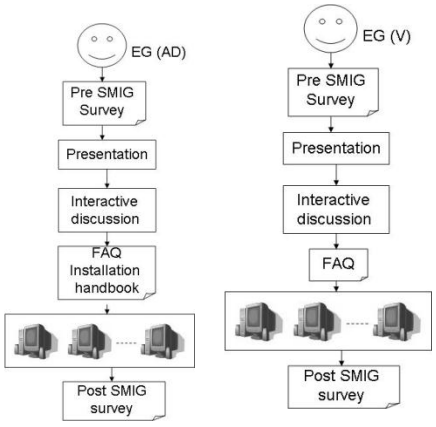

Figure 2: Communication Framework

The communication framework (figure 5) was implemented for volunteers and application developers separately.

VII. ANALYSIS OF RESULTS

The communication framework (figure 5) was implemented for volunteers and application developers separately. For volunteers the details of responses received from volunteers for presentation are detailed in table 9. Overall the responses were encouraging and volunteers were inspired to recommend the concept of volunteering to others.

TABLE IX. POST CF RESPONSES FOR PRESENTATION

Sr. No.	Survey questions	Yes	No	Not sure
1	Concept of volunteering	46	2	2
2	Overview of SMIG	42	5	3
3	Has the presentation encouraged you to donate your desktop power for any such high end application execution?	15	14	21
4	Has the presentation inspired you to recommend volunteering to others?	9	15	26
5	Were you satisfied with the overall quality of the presentation?	38	12	NA

After the presentation FAQ (Frequently Asked Questions) was distributed to the volunteering group through mail. The overall response of the group to FAQ was positive. The questions and related responses are listed in table 10.

TABLE X. POST CF (V) RESPONSES FOR FAQ

Sr. No.	Survey questions	Yes	No
1	Has the FAQ explained all the questions clearly?	43	7
2	Has the FAQ enabled you to develop a better understanding of SMIG?	39	12

After attending SMIG presentation and going through the FAQ the volunteer group was asked to use SMIG as volunteers to do their own work. They were asked questions to find out whether SMIG application execution running in the background hampered their work or not. The responses to these questions are tabulated in table 11. The volunteers could do their own work along with SMIG program running in the background.

TABLE XI. POST CF (V) SMIG USAGE FEEDBACK

Sr. No.	For each of these programs or applications (1-3) did your program take longer time to execute?	Yes	No	Not sure
1	Word processing	1	36	13
2	Playing recorded sessions	3	28	19
3	C/ Java programs or anti virus scan	2	32	16
4	Did you realize that SMIG was running on your machine?	8	37	5

The comments were summarized as follows: "Hands on usage of SMIG led to increase in confidence level of study group for volunteering and for recommending volunteering to others". The application developer group used the CF components of information dissemination – presentation, FAQ, Installation handbook and SMIG usage. The group was closely observed during the interactive discussion and SMIG usage. After this the EG(AD) group was given a Post CF survey questionnaire. The survey data was collected from the group of application developers through the Post CF survey form. The results are consolidated and discussed in the table 12. Overall the group understood the concept of volunteering, SMIG architecture, using SMIG for high end computations.

TABLE XII. POST CF EG(AD) PRESENTATION RESPONSE

No.	Survey Question	Yes	No	Not sure
1	Concept of volunteering	19	5	1
2	SMIG architecture and working	14	9	2
3	Concept of resource optimization	15	9	1
4	Overview of application development	21	3	1
5	Has the presentation encouraged you to donate your desktop power for SETI / UD or any such application?	8	14	3
6	Were you satisfied with the overall quality of the presentation?	14	11	
7	Has the presentation inspired you to recommend volunteering to others?	5	18	2
8	Has the presentation encouraged you to execute high application programs on SMIG?	3	20	2
9	Do you feel that the presentation inspired you to promote SMIG for high end computations to others?	3	19	3

After the presentation, FAQ was distributed to the group through mail and the responses collected from the group are listed in table 13. The group got a better understanding of SMIG after going through the FAQ.

TABLE XIII. POST CF EG(AD) FAQ RESPONSE

No.	Survey Question	Yes	No
1	Has the FAQ explained all the questions clearly?	21	4
2	Has the FAQ enabled you to develop a better understanding of SMIG?	19	6

Since the application developers had technical expertise, they were also circulated the Installation Handbook through mail. Responses were collected from the application developer group and are listed in table 14. The group got a clear idea of installation process from the handbook.

TABLE XIV. POST CF EG(AD) INSTALLATION HANDBOOK RESPONSE

No.	Survey Question	Yes	No
1	Has the installation handbook explained the installation procedure clearly?	23	2
2	Will installation handbook be enough to start installing SMIG?	18	7

The group members were asked to use SMIG as volunteers to do their work. Feedback was collected from the group and responses are detailed in table 15. They were asked questions to find out whether SMIG application execution running in the background hampered their work or not. Overall the group member's work was not hampered by SMIG job running in the background.

Using Communication Framework SMIG information was thus disseminated to population of volunteers and application developers.

TABLE XV. POST CF EG(AD) SMIG USAGE FEEDBACK

No.	For each of these programs or applications did your program take longer time to execute?	Yes	No	Not sure
1	Word processing :	3	18	4
2	Playing recorded sessions	5	16	4
3	C/ Java programs or anti virus scan	7	15	3
4	Did you realize that SMIG was running on your machine?	12	9	4

VIII. CONCLUSION

DSM and Grids focus on parallelizing applications and reduce hardware requirements and thus lower the installation and implementation costs. As a part of the doctoral work we have built SMIG (Shared Memory Integrated with Grid), a model which combines DSM and Grid computing paradigms. Literature citations indicate that some DSMs, Grids have hosted their home pages on the Internet, where they have given the source code and help documentation. Several research works in the area DSM based Grid have been published, but none of these research initiatives have been successful in reaching out to users beyond the campus.

Based on this survey a communication framework was designed and implemented to percolate SMIG information among potential users. The major advantages of designing the communication framework was to create awareness and enable users to promote the concept of volunteering, optimizing resources and use existing resources of SMIG for high end application execution. The communication framework included various tools like arranging overview sessions through presentations, handing written documentation circulate to users and also providing an opportunity to use the model. Feedback was collected after using each component of the communication framework. To summarize: the SMIG information and volunteering concept was transmitted to the group of volunteers and application developers. It was concluded that the motivational level of users to volunteer or donate resources was increased. The volunteer group members found it comfortable to use SMIG and the confidence level of group members to recommend SMIG to others also increased. The implementation of the communication framework among application developers has additionally enabled to promote SMIG for application development apart from volunteering their machines for SMIG execution.

Based on the implementation results it is evident that such a communication framework can be used for disseminating other technology developments to potential users. This is critically important in today's fast moving dynamic world where technological developments are happening on a day to day basis. Also there is a need to know what research is happening today and how researchers can contribute in enhancing it rather than doing working on it in the near future.

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