Implementing a Communication Framework for Disseminating SMIG Model to Potential Users

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ABSTRACT
Today processors and memory speeds slowly approach their physical limits and there is a need for parallel computing models. Recent developments in DSM, Grids and DSM based Grids focus on high end computations of parallelized applications. As a part of the doctoral work we have built a model which combines DSM and Grid computing paradigms into SMIG (Shared Memory Integrated with Grid). It was observed that just building an amalgamated model was not enough but there was a strong need to identify the potential category of users and prepare a communication framework to disseminate this information to them.
Hence in this paper we have surveyed and compared various communication techniques for disseminating DSM, Grid and DSM based Grid models. We have also designed and implemented a communication framework to percolate SMIG information to users. In the framework we have used various other methods (apart from those found in the survey) for promoting usage of technology in the communication framework like arranging overview sessions, handing written documentation on a one to one basis to users and also providing an opportunity to use the model. The detailed responses received from users after implementing the communication framework are also discussed. As a part of further research this communication framework can be used for disseminating other technical developments to potential users.

Keywords
DSM based Grid, SMIG, Communication Framework

1. INTRODUCTION
Today processors and memory speeds slowly approach their physical limits and hence it is becoming more convenient to use multiprocessors to increase computing power. Two parallel computing models are in use: loosely coupled and tightly coupled systems. Distributed Shared Memory (DSM) [1, 2, 3, 4] aims at combining the best of both models: ease of programming of tightly coupled systems (shared memory) and scalability of loosely coupled systems (distributed memory). They approach this goal by letting each processor have its own physical memory but all processors share the same unique logical address space.
Grid computing is another current trend for high performance computing which provides an efficient replacement for supercomputers. High-end computations can be easily parallelized and distributed among machines to speed up execution and share the existing underutilized resources.
As a part of the doctoral work we have built a model which combines SDSM and Grid computing technologies into SMIG (Shared Memory Integrated with Grid). During literature survey it was observed that most of the models evolved in academic research environments. But there was a lacuna in how these were communicated to potential users. To overcome this lacuna it was felt that just building amalgamated model was not enough but there was a strong need to identify the potential category of users and prepare a communication framework to disseminate this information.

In this paper we have focused on designing and implementing an effective Communication Framework to percolate information about SMIG to potential 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 users is put forth in section 4 and 5 respectively. The sections 6 and 7 give the details of the implementation methodology and results. Finally we end the paper with conclusion and future plan of action.

2. MOTIVATION FOR DSM AND GRIDS
Currently there is an inherent rise in development of software programs, algorithms and applications to cater to the increasing need of computer users. As program sizes keep on increasing, single machines may not have enough compute power to cater to this need. Two trends are explored for high performance computing namely: Distributed Shared Memory –DSM and Grid Computing revealed their advantages of optimization of memory and computing power respectively. The former trend provides an abstraction of a single virtual memory although the memories are physically distributed while the latter performs computing through sharing of existing idle/ underutilized resources thus providing an efficient replacement for supercomputers.

Parallel programs exhibit speed up and thus performance improvement in DSM environment but use dedicated computers. Grid computing allows optimization of existing computational power and is useful for parallel programs which can run independently but fails in case application needs to share memory. 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 as depicted in figure 1.

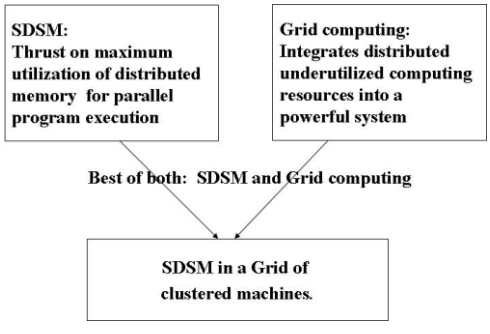

Figure 1 : Integrating SDSM with Grid

We have designed and developed SMIG by amalgamating SDSM and Grid models namely JUMP DSM (JIAJIA Using Migrating Protocol [5, 6] and of working principles of SLINC (Simple Light Weight Infrastructure of Network Computing [7]. The SMIG model will be released as an open source package.

3. OVERVIEW OF SMIG

SMIG comprises of a set of interconnected homogeneous machines with one Master and other machines configured as Hosts. The SMIG calls like initialization/ finalization, memory allocation and synchronization are all managed by JUMP code installed on the SMIG Master. The hosts are volunteers whose machines are available for application execution in the background. Once the hosts are configured the model is ready for execution of high end applications. The application program is parallelized using Master Slave technique and the applications which to be parallelized are submitted to SMIG Master for execution. Java scripts are run on hosts to detect the application process and assign a low priority to it for execution. 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 3.

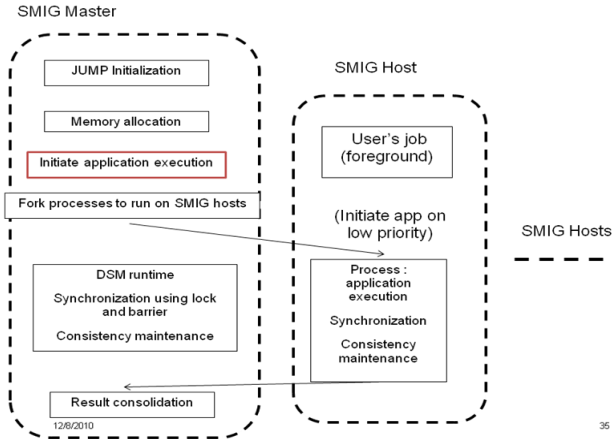

Figure 2: SMIG execution flowchart

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.

Once SMIG is installed, one of 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 and its performance times were recorded to check whether SMIG model is feasible and that the programs run to completion in finite time. The application execution results were categorized into sets of master execution time for: SMIG(0)-dedicated SMIG; SMIG(N)- with volunteers using SMIG hosts. Both with fixed number of hosts and shared memory. The third set included master execution time for variation in data size, shared memory and number of hosts keeping two fixed at a time. 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 always more than that on SMIG(0) with volunteers also using the hosts for their own application execution.

4. MOTIVATION FOR COMMUNICATION FRAMEWORK

Communication of information increases usage of any technical model, may lead to further research in that area and in turn evolve into new models. Keeping this in mind literature was surveyed to find out how information about specific technology developments has been distributed to users. Literature was extensively reviewed for identifying how DSM and Grid computing paradigms were percolated to potential users. DSM, Grids and DSM based Grids have been part of Master's and Doctoral research work in many academic institutes. 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 [8, 9]. Many of the efforts spent in communication have not been aligned to boost usage of these models, or encourage research in improving performance or modifying existing systems barring a few. The JUMP DSM home page is shown in figure 3.

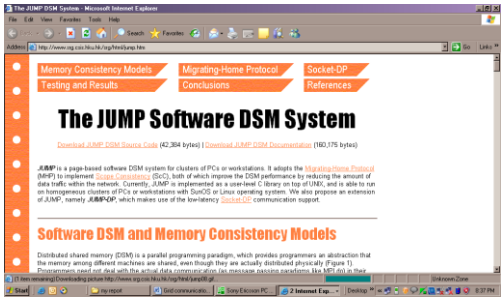

Figure 3: JUMP home page

For example: JUMP DSM source code and documentation have been 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.

Extensive survey was carried out to understand the communication techniques used by DSM, grid and DSM based grid researchers for information dissemination to users. 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 1: 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 2: 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 3: 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

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. This comparison has motivated us to build the Communication Framework (CF) with various tools to disseminate SMIG information to potential users. The major objectives of communicating SMIG information were identified as:

- To educate people the existence of underutilized computing power and memory
- To raise awareness of the concept of volunteering and the need for optimizing existing underutilized resources
- To propagate the knowledge of SMIG model to users to donate their CPU cycles and memory
- To encourage users to perform high end computations on SMIG
- To encourage users to promote SMIG for volunteering
- To encourage users to promote SMIG for high end program development.

5. PLAN FOR COMMUNICATING SMIG TO POTENTIAL USERS

Once the SMIG model was built and tested, the model was to be communicated to users. There was a need to focus on identifying alternative tools used in communication of SMIG model and thereby improving the communication process. The various aspects related to the communication process in the perspective of SMIG research are identified as: [11, 12, 13]

- Sender: It is the SMIG team comprising of software programmers.
- Message: Is verbal and written information about the model, it is newly prepared.
- Media: Is lectures through face to face communication and virtual classroom and questionnaire in written format
- Receiver: Identified two groups labeled as Volunteers and Application Developers. It is a mixed group of males and females in the age group of 25 to 40 years. Their academic background is graduation in Computers / Information Technology / Electronics etc. professional fields. The total number of receivers is about 200 people comprising experimental and control groups. The population description is illustrated in figure 4.

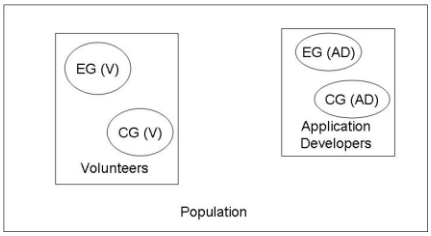

Figure 4: Population description

- Mode of communication: The basic modes of communication used are lecture and surveys.
- Feedback: Receivers were given a lecture on overview of SMIG and asked to use the model. Surveys were used to collect feedback from receivers about the impact of SMIG

communication. The feedback was also collected through observation of the study group during the interactive discussion and usage of the model.

- Effectiveness of communication: Quantitative-feedback was obtained from surveys and qualitative feedback was assessed from observation reports.

But there was a need to focus on identifying alternative tools used in communication of these technologies and thereby improving the communication process. Hence 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 communication was as follows:

- For Volunteers
  - Create awareness of SMIG among users
  - Enable the users to recommend the concept of volunteering on SMIG
- For Application developers
  - Create awareness of technical information of SMIG among users
  - Enable understanding of how high end computations can be executed on SMIG
  - Enable users to promote SMIG for high end computations

Literature was surveyed to identify the tools which can be used for communication, specifically in today's context of the dynamics in the IT Industry work environment. The various tools which can be preferred for information dissemination and feedback collection have been listed in table 4 and table 5 respectively.

Table 4: Preferential 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: Understand how SMIG works Understand how SMIG does not slow down user's tasks For application developers Understand how SMIG is used for high end computations

Table 5: Preferential Feedback collection techniques

Tool	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

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

6. IMPLEMENTATION METHODOLOGY

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

Table 6: 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 and (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 included those on quality, whether the message of volunteering and SMIG overview was understood. The details are listed in table 7.

Table 7: 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 usage)

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 8: Instrument: Interactive discussion / SMIG usage

Date and time	Atmosphere	Communication details	Monitoring	Observation comments	Summary
As per schedule	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 major advantages of suggesting and implementing the communication framework included:

- Disseminating the information about the ease of programming high end applications on this model to potential users
- Novel model for a trusted environment to execute high end applications
- Encourage users to use emerging computing paradigm as volunteers and promote donation of resources
- Users can promote emerging computing paradigm and optimize resources
- Useful for developing and executing high end computations on existing resources

The communication framework implementation for both volunteers and application developers are illustrated in figure 5 below.

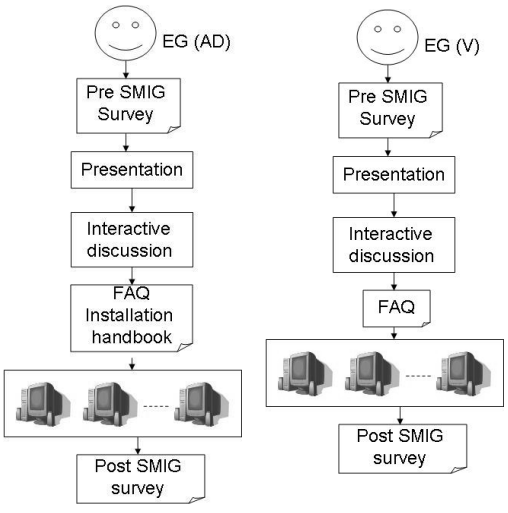

Figure 5: Volunteer's experiment design

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

7. RESULTS AND DISCUSSION

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 9 : 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 10 : 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 11: 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".

- For Application Developers

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 12: 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 13: 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 14: 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.

Table 15: 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

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

8. CONCLUSION AND FUTURE PLAN

Technology developments in DSM and Grids basically focus on high end computations of parallelized applications. Both computing paradigms reduce hardware requirements and 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. We have also listed a brief comparison of various communication techniques used for promoting use of DSM and Grids. Most of them 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 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 and described. 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 thee 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 any technology developments to potential users.

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