

Global Software Development: Building a Research Community

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Abstract

While the field of global software development (GSD) remains in its relative infancy, a group of GSD researchers are on the brink of building a stronger research community that will be able to collectively address many of the current challenges in the field. This paper details emerging issues in the GSD community while discussing contributions made at the latest GSD workshop held at ICSE 2004. These issues include: the need for community building and increased collaboration between researchers, the importance of more systematic application and documentation of research techniques, and the opportunity to build defined models and theories, and, in doing so, define the state of the practice. Brief summaries of workshop papers are incorporated, along with discussions of the topics addressed during the workshop. These topics include: Feasibility of GSD, Strategies for Success of GSD, and Research Methods and Challenges in GSD.

Keywords: global software development, distributed teamwork, intercultural factors, geographically distributed environments, empirical studies

Introduction

Global software development (GSD) is now widely recognized as a quickly growing phenomenon. In response to this dramatic shift in the software development field, industrial and academic researchers are interested in solving recognized and emerging GSD problems both as pragmatic and intellectual pursuits. While a significant amount of research within the field of GSD is being conducted, the need for improved collaboration has been recognized by many researchers.

The Third International Workshop on Global Software Development (GSD 2004) was held on May 24th 2004 in Edinburgh, Scotland, as part of the International Conference on Software Engineering (ICSE 2004). Attended by about thirty-five representatives from industry and academia, this venue provided an excellent opportunity to discuss recent developments, ongoing challenges and plans for the future.

Of the 17 papers submitted, 14 were accepted; all but two of these papers were presented by an author. Papers were solicited in the following categories:

- Case studies of GSD,
- Theories of communication, coordination, collaboration and knowledge management in GSD,
- Methods and tools to address challenges of GSD,
- Empirical evaluations of effectiveness of global software projects and
- SE methodologies & processes for GSD.

Note that the level of international participation in this event was excellent. Authors joined the workshop from North America (Canada and United States), South America (Brazil), Europe (Italy, Ireland, Finland, Norway and Germany) and Asia (India).

Research results were reported from case studies at large multinational corporations such as IBM India, Siemens and Analog Devices, whose industrial sites include: Finland, United States, Ireland, Singapore, India, and Brazil. Workshop participants represented many other parts of the world, including Australia and Africa.

The workshop program included a keynote presentation and three subsequent sessions that grouped paper presentations in three topics that emerged as important: Feasibility of GSD, Strategies for Success of GSD, and Research Methods and Challenges in GSD. To encourage interaction among participants, presenters answered questions related specifically to their own work and also served on a panel set up to address the larger issues that emerged during the discussions.

Workshop Topics and Papers

An underlying theme of improving intercultural communication was established by the keynote speaker, Philippe Kruchten, who addressed the impact of culture on GSD [1]. Based on his industrial experience and interdisciplinary research, Kruchten remarks that the Internet has not changed the country-dependent cultural aspects of programmers. He posits that project managers should be aware of cultural differences because GSD projects may succeed or fail due to 'subtle intercultural factors'. He encourages GSD researchers to take a more systematic approach when studying the impact of these same factors.

The three sessions following the keynote presentation addressed broader issues within GSD while referring specifically to the content of the presented papers.

Feasibility of GSD

Led by Elizabeth Hargreaves, this session considered both the short and long-term feasibility of GSD projects. Since empirical data determining this level of feasibility has yet to be gathered, discussing the authors' experiences with specific projects serves as an initial foundation for more extensive discussions of this topic. In addition, the feasibility of GSD projects is of particular interest to industry practitioners keen to adopt GSD practices as well as for academic researchers investigating this topic.

The first presenter, David Boland, described his paper which analyzes the transition from a co-located to globally distributed environment within the framework of a specific case study performed at Analog Devices. In *Transitioning from a Co-located to a Globally-Distributed Software Development Team: A Case Study at Analog Devices, Inc*, Boland discusses from a first-hand perspective the impact of transferring previously collocated team members from the United States to Ireland and the negative impact that this relocation had on trust levels within the team [2]. Of particular interest was Boland's reference to the 'CTS culture' in relationship to the theme of cultural factors which pervaded the workshop discussions as previously mentioned. (Note that CTS is a product

developed by Analog Devices).

Matthew Bass' work provides insight into the GSD strategies used by Siemens—one of the most globally distributed software companies in the world [3]. *Global Software Development Process Research at Siemens* primarily addresses organizational, technical and product factors. This paper includes Siemens' best practices which include: the recommended duration of development cycles, reasons for outsourcing, explicit project goals, and strategies used to synchronize project management between distributed sites and reduce communication need, such as having a local domain expert on each site. Currently, Siemens is in the process of codifying these practices for distributed development.

Presented by Casper Lassenius, Zheng Yan's [4] case study highlights the GSD challenges experienced first-hand during the maintenance phase of an e-commerce project. *Efficient Maintenance Support in Offshore Software Development: A Case Study on a Global E-Commerce Project* focuses on some of the difficult challenges of GSD, such as having no overlapping time between the two sites located in US and Singapore. The case study also features a questionnaire and phone interviews that attempt to elicit richer details of the observed phenomena from the development team members. Based on this work and future studies, Yan intends to develop a series of guidelines for maintenance agreement generation and execution.

Finally, Rafael Prikladnicki presented *Risk Management in Global Software Development: A Position Paper* which highlights risk management issues related specifically to GSD projects [5]. Prikladnicki has developed his expertise in GSD based on his experiences with Dell outsourcing in Porto Alegre, Brazil. Based on observations that GSD involves additional factors that can impact risk management, the authors wish to evaluate the effectiveness of the risk management process in multinational organizations that practice GSD.

Strategies for Success of GSD

This session, mediated by James Chisan, considered a variety of methods for effectively conducting GSD. Despite concerns over moral or ethical issues regarding offshoring, the trend toward the globalization of software development is indisputable. Thus, this session was designed to give researchers and practitioners studying and practicing GSD the opportunity to share and learn from one another. Not only are practical techniques and ideas critical for promoting improvement in the field, but practitioner experience provides direction for future research.

At the beginning of this session, Elizabeth Hargreaves presented the ideas described in her position paper which suggests that there may be key similarities between teams that operating in GSD and military environments [6]. In *Can Global Software Teams Learn from Military Teamwork Models?*, Hargreaves draws parallels between the two working contexts, including: communication demands, trust requirements and stress levels. Finally, she asks whether the adoption of some aspects of military teams (such as a defined code of conduct or a visible subculture) may be beneficial for GSD teams.

Hans Nissen followed, describing his work, *Designing the Inter-Organizational Software Engineering Cooperation: An Experience Report*, which relates the experiences of an organization

moving its in-house development to an external service provider [7]. Nissen explained how the organization prepared for this change and utilized cooperation models to manage expectations. The next step in his work is to collect experiences from companies and create additional cooperation models to develop "GSD process patterns" intended to guide customer-supplier interactions during GSD.

Next, James Chisan contributed by explaining how his model, described in *Towards a Model of Awareness Support of Software Development in GSD*, could improve cooperation and communication among software developers who do not enjoy the benefits of co-location [8]. Although the model presented merely identified where and how communication breaks down over the software lifecycle in GSD scenarios, attendees were invited to provide critique. Input provided will be incorporated into future models which will serve as the basis for a requirements awareness tool.

In *Peer-to-Peer Remote Conferencing*, Fabio Calefato presented a tool he designed to more effectively conduct remote text conferencing [9]. He proposes that separate organizations involved in GSD may find such a tool valuable in order to conduct remote meetings and to enable inter-site collaboration. Work continues to proceed on this tool to improve deployment, automating configuration and support for presentation sharing.

Finally, Bikram Sengupta of IBM Research India introduced the idea of *Test-Driven Global Software Development*, his position paper which addresses incongruities caused by frequently changing requirements [10]. His approach dictates a test-based-programming process that conveys requirements in the form of test artifacts. This technique serves to enforce more rigorous requirements and to coordinate development on the test artifact itself. Sengupta proposes to advance this position through empirical validation and, eventually, tool support.

Research Methods and Challenges in GSD

The need for empirical research in GSD is indisputable. Whether the research is about success factors of global teams, the development of theories about GSD or evaluating proposed strategies, the role of empirical data from real-life software industrial settings is critical. The fundamental question that emerges is which research methodologies, strategies and techniques are appropriate for the collection and analysis of empirical data such that we achieve a systematic advancement of knowledge in this growing area of research. Without trying to exhaustively discuss the research methods used or proposed by all papers in the workshop, in the following paragraphs we present a preview of the papers and the research methodologies used in the papers selected for presentation in this session led by Daniela Damian.

Interviews and inspections of project documents were discussed as methods used to identify collaboration practices in GSD, in *Using iterative and incremental processes in global software development* by Paasivaara and Lassenius [11], and in *An empirical study of global software development offshore insourcing* by Prikladnicki et al [13].

Similarly, Cherry and Robillard discuss the study of ad-hoc communication through direct observations of global teams, in *Communication problems in global software development: spotlight on a new field of investigation* [12]. Their principal method for col-

lecting a large amount of data was via audio-video recordings of working sessions.

Further, Kruchten proposed the study of intercultural factors through a combination of ethnographic studies, content analysis, surveys and experiments, in his paper *Analyzing intercultural factors affecting global software development* [1]. This strategy is similar to that of Dingsøyr and his colleagues who plan to implement a multidisciplinary approach in studying global teams in both commercial and open source projects, as described in *The benefits and limitations of knowledge management in global software development* [14].

This session attempted to identify methodological issues such as: what are the challenges in applying “traditional” empirical methods in the context of geographical distribution of study participants, and whether factors such as trust and cultural differences that affect global software development are having an impact on how research is carried out in this field. Discussions about GSD research methods and their pitfalls are potentially very beneficial not only for research projects in the initial planning stages but also in understanding the results and limitations of existing research.

Emerging Issues

The following issues emerged throughout the course of the workshop and during discussions held at workshop dinners and informal meetings before and after the workshop. The future of GSD research looks particularly promising if the following issues can be addressed in the near future.

Increased Community Building

Despite research in GSD being in its relative infancy, it appears that enough interested individuals and research groups wish to build and contribute to a GSD research community. The benefits of developing such a community are significant and cannot be ignored. An ongoing exchange of information in the GSD area and the creation and maintenance of a web portal to serve as a repository of research resources (e.g. articles, project information, events) are only some of the goals of this community.

Further, the topics addressed by GSD research are potentially very broad and warrant the attention of researchers outside the realm of software engineering. Research in GSD not only greatly benefits from collaborations with other disciplines such as computer-supported cooperative work, human computer interaction and business and social sciences, but it creates opportunities for such interdisciplinary interactions. These opportunities could be very fruitful for everyone involved, especially in light of increased globalization in most industries. At the same time, establishing and coordinating this type of collaboration can be too challenging if working in isolation.

Another benefit of a more defined community includes the opportunity for the community itself to act as a test bed for developing and evaluating collaborative tools both independently from and in tandem with industrial partners. Tools for asynchronous and synchronous communication could be used in contributing to the community resources web portal as well as the organization of virtual workshops and working meetings. The resulting recommendations and creative solutions about successful use of these

tools could be invaluable.

To date, the goals of this community are being refined. To foster discussion in the community and enable the exchange of information between interested researchers, a mailing list (gsd@mailman.cs.uvic.ca) and a prototype website have been created.

More systematic application and documentation of research methods

Research that builds upon empirical data is critical in ensuring that it has practical applicability for the industry practitioners faced with GSD problems. Development and testing of theories, as well as testing of methods and tools greatly benefits from empirical research methods such as experiments or exploratory case studies. While the application of these research methods is only appropriate, borrowing existing research techniques from other disciplines without developing a solid background and understanding of issues of applicability can compromise the integrity of the research. Still unanswered is how to appropriately leverage and adapt existing research methodologies that are used more extensively in other disciplines. Do we face challenges in applying “traditional” methods when conducting research in GSD? Does the geographical distance as an element of the software development setting pose challenges to conducting the research itself?

Difficulties in maintaining a global view in case studies of GSD have already been documented [15]. Ensuring the collection of research data from multiple sites is heavily dependent on the researcher’s ability to involve the relevant participants at remote sites and to conduct observations of activities at remote sites. This in turn depends on the research team’s success in establishing links at remote sites (or work with internal sponsors [13]) such that trust relationships can be built and support the collection of meaningful research data.

In addition, developments in GSD are often informed by our understanding of collocated software teams. The need to advance research findings in this direction has never been greater. However, the collection and analysis of data about face-to-face group behavior is equally challenging as GSD investigations since collocated software teams also engage in a complex interplay of physical and computer-mediated interaction. Collocated team members may interact electronically using tools such as email and instant messaging; subsequently, simply recording verbal conversations when studying collocated teams would appear to be insufficient.

A strong GSD research community would be able to provide the resources necessary for those learning about new research techniques and supply feedback during the design phases of GSD studies and experiments.

Building Defined Models and Theories

One outcome of developing stronger research methods is the potential to systematically build models and theories for GSD. Models and theories not only empower practitioners and researchers when developing individual studies but also provide the opportunity to perform comparative as well as meta-analyses and consider GSD problems more thoroughly. In addition, defined models and theories are powerful tools that facilitate the teaching of GSD in universities and colleges. The need for and subsequent process of

developing models and theories can be viewed as an indication of maturation within the field of GSD itself.

Defining the State of the Practice of Software Engineering

During the workshop discussions, a certain level of dissension about the “true” state of the practice was observed. Perhaps this dissension in fact reflects the state of the practice—are there significantly different ways of developing software? If so, should research methods used to explore current practices be equally varied? Would a high level of variation in research techniques permit broad analyses and comparisons between studies? Perhaps this question can only be answered by determining the overreaching goals of the GSD research community itself.

Conclusions

One of the goals of this workshop and our ongoing work is determining how to respond to such a tremendous shift in the way software is developed. Examining existing methodologies within the field of software engineering and borrowing from other disciplines remain valid approaches for overcoming GSD hurdles. Many other strategies for solving GSD problems are still to be discovered. It is our hope that this event and subsequent activities will provide rich opportunities for interested parties to develop solutions to GSD problems and collaborate successfully with other researchers.

Future Work

Note that the workshop organizers are considering turning upcoming workshops into two-day events in order to facilitate longer discussions and increased collaboration between participants. There was also an initiative to meet more frequently—including meeting remotely via collaborative tools in order to ‘practice what we preach.’

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