

# Fostering Cross-site Coordination through Awareness

An investigation of state-of-the-practice through a focus group study

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**Abstract**— Awareness and shared knowledge are important ingredients of successful coordination in software engineering projects, and especially when team members are distributed. Although various coordination mechanisms and knowledge sharing recommendations for cross-site collaboration have been proposed, spreading awareness among distributed team members has proven to be challenging in practice. In this paper we discuss our findings from conducting three focus groups on knowledge management in global software collaborations in two international organizations. We discuss various awareness needs in globally distributed collaborations that were not addressed by the organizations, and conclude that best practices and tools proposed in related research are not widely used. On the basis of our empirical findings we suggest future research directions and share recommendations for practical improvements.

**Keywords:** Knowledge Management, Awareness, Coordination, Global Software Development, Global Software Teams, Focus groups

## I. INTRODUCTION

Software development projects nowadays often involve globally distributed work. The distribution in global projects takes various forms. Software developers are spread across a network of collaborating organizations or offices of the same organization in different countries; software teams are working remotely from project managers and product owners; testing is performed on a distance; products are customized for local markets by remote specialized teams, etc. The role of coordination in such environments becomes central. Coordination is necessary not only to manage interrelated tasks, but also to ensure the availability and accessibility of knowledge necessary to efficiently perform the tasks. Research suggests that effective coordination is enabled through shared knowledge of the task and shared knowledge of the team [1]. Cramton [2] also explains that mutual knowledge or, in other words, awareness that the others know particular information, is a building block of successful communication and coordination. The importance of awareness in cross-site collaborations has been discussed in different research fields, including organizational theories, coordination theories, and collective mind theory. In global software engineering several types of awareness needs are distinguished — awareness of activities at the other sites,

awareness of the task, presence and availability awareness [1, 3, 4]. Espinosa et al. [5] demonstrate that geographic dispersion increases software development schedule time and that the effect of work familiarity is stronger for geographically distributed teams than for co-located teams. Nonetheless, spreading awareness and knowledge to all levels in real time practically has proved to be a real challenge [6]. Related empirical research suggests that despite the availability of tools and guidelines that promote knowledge sharing, cross-site communication in four studied projects was limited [7]. Cramton [2] explains that people from different locations are likely to have different information and not know it. Organizational culture, processes and tools also are likely to differ across locations and affect the way awareness is managed [8]. Other studies have attributed a lack of awareness of work and progress at remote sites to a lack of informal communication [9, 10]. As a result of poor awareness of the context, remote partners suffer from misunderstandings and false assumptions, and often fail to anticipate and communicate the differences that could help prevent the damage to collaboration [2, 8].

In this paper we empirically explore awareness challenges in three global software collaborations in two international organizations. This research shows state-of-the-practice of existing recommendations and best practices in typical global projects. Further, the study seeks to understand why spreading awareness in global projects is difficult.

## II. RELATED WORK

The question of how to help distributed groups collaborate has been the focus of the *computer supported cooperative work* (CSCW) field. Awareness has been a central topic, where much of the work was done in the 1990s [11]. In this field, awareness is defined as "an *understanding of the activities of others*, which provides a *context for your own activity*" [12].

Empirical studies show that the availability of tools and guidelines does not necessarily mean that remote teams apply them in practice [7, 8]. Awareness challenges cannot be fixed by technical solutions alone, but require a cultural and behavioral shift [8].

Some forms of awareness can be achieved through knowledge management systems, which most companies are using today. It is therefore interesting to discuss what kind of awareness support provided by these knowledge management systems is used in practice, which types of awareness are supported and which are lacking in these solutions.

For this purpose, we have chosen to use a modified version of a framework suggested by Gutwin and Greenberg [13] for workspace awareness. Their definition of workspace awareness is "up-to-the-moment understanding of another person's interaction with the shared workspace". In our context, examining awareness of a shared project as facilitated by knowledge management system, the focus is on a somewhat different setting. The project participants have a shared "workspace" manifested in a number of supporting tools, routines and practices where some are not supported by computers such as video-conferences and telephone calls. Yet, as we have argued previously, there needs to be an awareness in global projects, and the elements of workspace awareness give answers to questions like "who", "what", and "where" which are crucial in order to gain an understanding of a project. Thus an adapted version of the framework is used for our study, and is shown in Table 1. The framework consists of 14 awareness elements, grouped into eight categories. The first four categories contain elements in the present, grouped in "Who", "What", "Where", "How". Table 1 shows questions for each category, such as "Is anyone else working on the project?" for "Who". The other four categories contain elements in the past, "When", "Who", "Where" and "What". The rightmost column in Table 1 lists awareness practices and tools relevant to each element, which we further describe in more detail.

### Who

Recommendations regarding face-to-face meetings and frequent communication have already become clichés in the global software engineering literature. The importance of getting to know each other has been widely discussed [2, 14], and experimentally explored [15]. Cramton suggests that mutual visits let people from remote locations see how a partner's situation differs from one's own and to absorb details that a partner may neglect to mention [2]. Bhat et al. [16] suggests establishing an awareness system, outlining people's roles and responsibilities. Several researchers also refer to project homepages with team-specific information as a resource to get to know other team members [6, 14].

### What

Frequent communication and feedback exchanged through mutual adjustment has been found to be essential for overcoming complex tasks [17]. Storey et al. [18] give an overview of specific tools to support awareness of human activities in software development. An example of such tools is Palantir, which is designed to avoid coding conflicts between developers.

### Where

The practices and tools that are described under *who* are also relevant for giving awareness of *where* participants are working.

### How

Many companies are using electronic process guides to describe work processes [19]. Version control history can explain why an artifact is in a specific state [18].

### When

A project homepage can summarize progress metrics and planning information [6, 14].

TABLE I. Elements of workspace awareness, adapted from Gutwin and Greenberg (2002). Modified or new elements marked with \*.

Category	Element	Question	Awareness Practices and Tools
Who	Presence*	Is anyone else working on the project?	
	Identity	Who is participating? Who is that?	Project homepage: team-specific information [6, 14] F2F and getting to know each other meetings [2, 14, 15]
	Role*	Who is doing what?	
	Responsibility*	Who is responsible for what?	Project homepage: roles and responsibilities [16]
What	Action	What are they doing?	Frequent communication and feedback exchanged [17]
	Intention	What goal is that action part of?	
	Artifact	What objects are they working on?	Version control tools: artifacts under development [18]
Where	Location	Where are they working?	Project homepage: team-specific information [6, 14] Mutual visits: contextual details [2]
How	Work procedure*	How is this task carried out?	Description of work practices in electronic process guides [19]
	Artifact history	How did this artifact come to be in this state?	Version control tools: visualization of change history [18]
When	Event history	When did that event happen? When changes occurred?	Project homepage: progress metrics, planning information [6]
Who (past)	Presence history	Who was here, and when?	
Where (past)	Location history	Where has a person been?	Shared calendars [4]
What (past)	Action history	What has a person been doing?	Visualization of version control history [18]

### **Who and where (past)**

Storey et al. describe Seesoft, a tool to visualize the history of version control data [18]. Also, shared calendars provide the history information on who and where in retrospect [4].

## III. RESEARCH DESIGN AND METHOD

In this section we explain the design of the research and describe the empirical background of our study.

### A. Data collection and analysis

Our research is motivated by the willingness to improve the efficiency of global collaborations through a better understanding of the role of knowledge sharing in coordination of work within and across locations participating in global software engineering projects. In this paper we address the following research questions:

*RQ 1: What knowledge is important to share to improve awareness in cross-site collaborations?*

*RQ 2: Are awareness support solutions suggested in related literature applied in the studied collaborations, and if not, then for which reasons?*

To address the research questions we first performed a focus group study, and then compared the findings with awareness support solutions identified in related research literature. An overview of the research activities is given in Table II.

Three focus groups were conducted in two organizations, which we here call Alpha and Beta, to explore knowledge sharing needs in globally distributed projects. Organizations were selected based on accessibility. Each organization selected participants for focus group from global collaborations that were seen as good candidates for improvement. Both focus groups in Alpha were organized in Sweden in November 2011 and were moderated by the two researchers. The first focus group was co-located and included only onshore participants from Sweden, while the second focus group involved Swedish staff and staff from a remote location in India. Research activities were therefore mediated through a video-conference and a shared screen.

Both focus groups in Alpha were held in English. The focus group in Beta was organized in December 2011 at the offshore location of the company, and was moderated by one researcher. The workshop was held in Russian.

We followed focus group research methodology [20] to structure and moderate groups of practitioners. Each focus group lasted four hours and followed a similar predefined agenda:

1. Introduction
2. What knowledge is important daily?
3. Which knowledge is local and which global?
4. How is knowledge shared and maintained?
5. What is easy to share, and what is hard?
6. What can be improved?
7. Closure

One researcher moderated the focus group, assigned work and discussion tasks and kept the workshop on time. Agenda item 2 was organized as an individual brainstorm with plenary presentation and discussion to make an overall map of important knowledge areas. Then, groups would discuss areas of knowledge and determine whether the knowledge is kept locally or globally (3), how it is shared (4), and what is easy and hard to share (5). Finally, all participants were given time to suggest improvements (6). For the workshop carried out as a video-conference, participants were divided into groups by location. The moderator sought to ask open-ended questions for agenda items 2, 4 and 6 while information produced so far in the workshop was classified into predefined categories in 3, and 5.

The results of each workshop were documented and sent back to the participants. Data collected during the focus groups was analyzed with the help of thematic coding. In this paper we present our observations related to awareness needs and knowledge sharing challenges. Although all focus groups were structured, the moderators had no influence on the outcome. Therefore the resulting information represent opinions of participants about knowledge sharing in a selected situation and in the given moment of time. Although some findings could be applicable to all three collaborations studied, we do not make any generalizability claims and

TABLE II. Research activities

Activities	Participants	Focus
Focus groups	Alpha: Sweden – China (W1) <i>Onshore architects, developers, testers, and line managers</i> 6 participants	Collaboration on development of software product components using a shared platform
	Alpha: Sweden – India (W2) <i>Onshore developers, testers, team leads, offshore developers, testers</i> 7 participants (4 onshore + 3 offshore)	Collaboration on development of software product components using a shared platform
	Beta: Sweden – Russia (W3) <i>Offshore developers, testers, team leads</i> 7 participants	Collaboration on maintenance and development of software applications, specified onshore and developed offshore
Observations	Offshore site visit at Beta.ru	

trace each finding to its source. Finally, research observations were discussed in dedicated seminars in each company.

In contrast to many empirical studies that take only a single perspective we were able to obtain opinions from an onshore location in the first workshop, onshore and offshore locations in the second workshop, and offshore location in the third workshop.

### B. Case description

The first organization, which we call Alpha, is a large international company headquartered in Sweden. Alpha is developing software intensive systems and is rapidly extending its operation in Asia. We held two focus groups exploring collaborations involving sites in Sweden, China, and India.

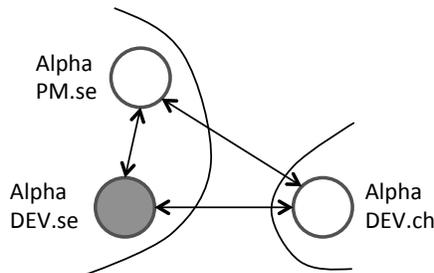


Figure 1. Organizational setup in the first focus group.

The first focus group was held with participants from a large-scale software development project. Swedish and Chinese development sites in this project are involved in developing a component for a compound system. Coordination among these sites is primarily necessary to manage the shared parts of the platform, on which the components are built. The project follows Scrum methodology and is further split into multiple development teams in each location. Thus coordination takes place among the teams locally and globally. Although direct project management is co-located with each of the development sites, product management is performed on a distance, from yet another remote site in Sweden.

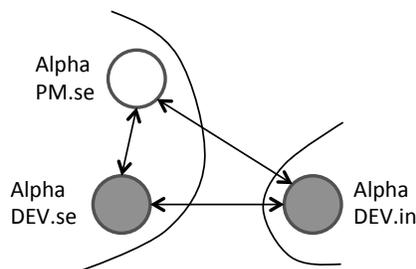


Figure 2. Organizational setup in the second focus group.

The second focus group was held with participants from two related software development projects, one in Sweden and the other in India. Each development site is working on a product that has interfaces to a common platform. Swedish site includes 20 project members and Indian team is equally large. Similarly to the first focus group project, product

management in these projects are also performed on a distance from a remote location in Sweden. Both projects follow the Scrum development method.

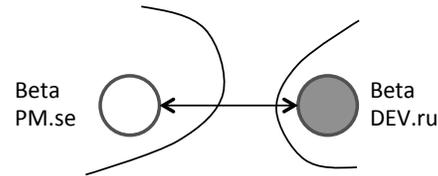


Figure 3. Organizational setup in the third focus group.

The third focus group was held in Beta, a large international organization headquartered in US. Our study focused on the collaboration involving sites in Sweden and Russia. The site in Russia employs twenty people, who have collaborated or are currently involved in collaboration with the Swedish site. Participants from three small-scale software development projects were involved in the focus group. In all projects development is primarily performed in Russia, while project and product management is kept in Sweden. Two out of three projects recently implemented some elements of Scrum, and will continue to expand the use of agile methods in the future.

## IV. RESULTS

In this section we outline awareness obstacles that we have identified in distributed collaborations studied during the three workshops (W1, W2 and W3) and summarized in Table 3. The findings are mapped to the workspace awareness model (See Table 1), which is adopted from Gutwin and Greenberg [13]. This helps us in evaluating which elements of an awareness system are most challenging. Interestingly, we have found challenges in relation to almost every awareness element, which demonstrates that awareness is an important topic to be addressed in global projects. The elements, which were not specifically discussed or highlighted in our workshops, were Intention (What), Presence history (Who / past), and Location history (Where / past).

### Who

Although both organizations had corporate knowledge management systems in place, these systems did not always support project-level knowledge sharing. We found multiple needs of spreading awareness related to the team members that caused challenges.

In W2 we learned that the information about holidays and vacations and team member availability, although codified in the corporate systems, was not shared across sites. This caused troubles when e.g. Indian colleagues attempted to contact their Swedish counterparts, who were unavailable due to the national holidays.

Messaging tools are often used to support sharing of individual presence and availability information. However, in W3 we learned that implementation of such tools needs to be planned. A variety of tools were used in Beta at different points of time, which caused confusion due to the

TABLE III. Cross-site knowledge related to awareness — Findings from the focus groups

Category	Element	Source	Identified Challenges
Who	Presence	W2	Sharing the information about vacations across sites: contingencies are challenged
		W3	Sharing presence-awareness: due to frequent changes in corporate guidelines support tools are used inconsistently
	Identity	W1, W2, W3	Understanding who knows what: not documented well
	Role	W2	Creating a clear view of roles
	Responsibility	W1, W3	Creating a clear view of responsibilities
What	Action	W2	Sharing the information about the status on the other side and daily progress
	Intention		
	Artifact	W1	Access to data in databases across sites is protected
Where	Location	W1	Sharing a common vocabulary
		W3	Navigating through a large amount of artifacts is hard, when data sources are not indexed
How	Work procedure	W1, W2	Sharing an understanding of the sense of quality
		W2	Achieving a shared background, experience and understanding of the numerous processes
		W3	Aligning processes across projects and sites and implementing new processes: Processes descriptions were not communicated across sites
	Artifact history	W2	Sharing the information about dependencies and future changes
When	Event history	W1, W2, W3	Understanding current status: documents are not always updated, people at remote sites are not notified of the changes
Who (past)	Presence history		
Where (past)	Location history		
What (past)	Action history	W2	Sharing experiences across teams: knowledge from team retrospectives stored in corporate databases was not shared

inconsistency. Different colleagues favoured different tools. This prevented the achievements of benefits that the tools could have provided for presence awareness.

Gaps in understanding “who knows what” were stressed in all three workshops. This information was not codified. Although co-located team members knew each other well, familiarity with colleagues from other teams (in large projects) and from remote sites was challenging. Meetings usually provide individuals with the possibility of obtaining knowledge about where they can obtain further knowledge [Aubert]. However, if the meetings are held only locally, the cross-site links are not created. Participants from W3 admitted that it is very difficult to create a contact network with remote colleagues. Building personal relationships due to a lack of face-to-face interaction is said to take a very long time.

Cross-site coordination of roles and responsibilities of the team members was also emphasized as a challenge. Project members from onshore and offshore locations in W2 said that the understanding of the roles of other teams was lacking. Although their responsibilities for respective components were split, the changes in the shared parts were associated with the major concerns. However, there were no project-dedicated homepages and tools other than the version control systems were not used to coordinate these changes.

Definition of roles and responsibilities is also necessary to guide developers to those with decision power. The knowledge of authorities across sites was said to be missing

in W1 and W3. In fact, due to the frequent changes in Alpha, employees said that the lack of such information caused a lot of confusion.

### **What**

Lack of transparency and clarity of roles also reflected in understanding the task related information. Participants in W2 admitted that the daily progress on the other side was often invisible. This was troublesome for remote teams working on the same platform.

Frequent feedback exchange suggested in related work was seldom used in the studied focus groups, since the responsibilities were split. In fact, the goal of component development in the Alpha case aimed at minimizing the cross-site communication and coordination. Therefore, the task-related information circulated locally rather than globally.

Participants in W1 described that each site managed the knowledge locally in their own repository. In some cases each site implemented access control means to protect the information. Therefore, some artifacts were even inaccessible for remote colleagues.

Participants of W1 additionally referred to the problems in understanding what is what. Participants said that it is important to share a common vocabulary, because terminology in different sites varies. However, no indexes or formal vocabularies were maintained.

**Where**

We learned that project knowledge was usually stored in different places and not in a single dedicated computer system. A certain amount of redundancy increases the chance that everyone will receive the desired or necessary information, but is problematic when it confuses the developers [21]. Participants in W3 complained that knowledge is difficult to find ("*unsearchable knowledge*"), because the links to "what is where" are rarely defined. Only one participant shared positive experiences from developing a wiki page with references to different document storages, which was far from the common practice across the organization. Also in Alpha finding the knowledge was problematic.

**How**

From all three focus groups we learned that processes across sites differ, but there is no shared understanding of the numerous processes in the lack of presence of a shared background and experience. One of important difficulties identified in W1 and W2 was alignment of certain tacit knowledge areas. Participants described that they do not know how to share the knowledge about the notion of good and bad code quality and test quality. This knowledge is usually shared through informal discussions and joint work experience locally. Previous attempts to codify this knowledge for global sharing did not improve the shared understanding. In W3 we learned that the offshore site had difficulties in adapting agile methods, which were not documented, while later we learned that the process documentation existed, but was not shared. The discussion with the offshore employees revealed that the vast majority of codified procedures are not consulted, and well-known work practices are commonly reused from previous projects.

Sharing the information about dependencies and future plans was regarded as challenging in W2. Understanding dependencies on e.g. design level often requires involvement from both sites, which was recognized to be hard.

**When**

The lack of awareness of progress and future plans reported across the sites in W2 is also related to hindrances in understanding of event history. In the case of W2 this complicated the control over dependencies. Similarly in Beta where a lot of knowledge was codified, participants in W3 complained that remote project managers did not always update the documents and tacit information about changes was also missing due to distance. Similar situations were discussed in W1, when remote product managers did not manage to maintain the list of requirements. Prioritization of requirements changed frequently and updates were not maintained.

*A. Gaps between research and practice*

Related work demonstrates the breadth of solutions for computer supported cooperative work, while our findings suggest that little of the available technology for awareness is used in practice. For example, better awareness of what artifacts other participants in the project are currently working on could enable more intense collaboration. Both companies invested in large corporate-level knowledge management systems, which became "black holes" [22], places where the knowledge flows in and becomes inaccessible. While information storing is crucial for remote knowledge exchange, means to support fast feedback and notifications were unfortunately missing. We learned that team members discussed the updates locally. At the same time links to important information, and the awareness of who knows what across sites were often missing. This is in line with previous findings that awareness cannot be created just through implementation of technical solutions alone [8].

Our findings also show that much information that is necessary to create the shared workspace awareness was not maintained. For example, we did not find the use of team-specific knowledge, shared calendars, and cross-site progress metrics. The focus group participants further related these awareness gaps to different coordination problems. Dominance of local knowledge sharing practices often led to a lack of transparency across sites, which impede cross-site work coordination. Our findings thus confirm existing research that suggests that awareness and coordination of work go hand in hand [1, 4].

*B. Differences across sites*

We learned that the use of awareness tools and favourable practices of sharing information might differ across locations of a global project. For example, we have found an inconsistent use of presence awareness tools, and also an asymmetric use of codified work procedures. This confirms the advice given by Cramton, who emphasizes that designers of dispersed teams should aggressively explore and if possible align the differences in team members' local situations that could affect collaboration [2].

We have also found several cases, in which the cross-site differences were previously unexplored. For example, we learned that the offshore project members in Alpha who complained about the lack of information about vacations and holidays at the onshore side were not aware of the availability of this information on the corporate repository. From discussions in Beta we also learned that the offshore project members were not aware of the availability of the new work procedures in the corporate repository, while the onshore project members were not aware that their offshore counterparts are not regularly consulting the repository. These findings stress the importance of exploring and bringing the differences into attention, even though some of the differences may not be possible to address [2].

### C. Knowledge codification is not enough

We believe that the achievement of awareness in global teams is more challenging than in local team. Focus groups participants revealed that the codified information is often supported through informal awareness sharing locally. For example, it is not uncommon that developers are notified about the changes in requirements and other updates, when meeting by the coffee machine or during lunch breaks. Unfortunately, distance introduces major challenges for informal communication and knowledge sharing, and thus remote teams are often isolated. Out of reach of these awareness mechanisms, they can rely mainly on the codified information. We suggest that this shall be addressed by fostering awareness through computer supported cooperation technology that enables lightweight, easy to use information sources, and at the same time enabling opportunities for informal collaboration. For example, we have found the need for such features as indexes, links and notifications to ease the information elicitation. There seem to be a large potential for implementation of advanced awareness solutions in practice.

Finally we suggest that fostering awareness requires a mind shift and not just tools. The challenges brought about by the distance will be mitigated, but will remain to a certain degree. Thus, the awareness mechanisms and practices in global projects require dedicated strategies, work habits and culture, in order to avoid the obstacles that we have identified in the three focus groups.

## VI. CONCLUSION AND FUTURE RESEARCH

In this study, we have investigated awareness practices in two international organizations, taking an onshore, "bothshore" and offshore view. Although various recommendations have been proposed, the state-of-the-practice regarding cross-site awareness seems immature. From conducting three focus groups we evidenced multiple challenges in spreading awareness and have identified a lack of general mutually agreed on strategies on how to achieve awareness.

In response to *RQ1* we found the necessity to share different elements and awareness of who, what, where, when and how. We mapped the challenges discussed in the focus groups to the workspace awareness framework proposed by Gutwin and Greenberg [13], and adopted it to include software project-specific elements, such as presence, roles, responsibilities and work procedures, that were found important in the collaborations studied. In summary, we learned that remote teams require to have a good understanding of who is who, who knows and does what, what is where and what is changed when, what needs to be done when and how, and what is interrelated. We believe the CSCW field has a number of relevant theories and concepts that can be explored also in a global development setting.

In response to *RQ2* we conclude that no evidence of implemented solutions of specific awareness technology discussed in related research were seen in the organizations studied. This means that the potential of available tools is not

exploited. We thus see an opportunity for industry to try out different solutions and evaluate their benefits for supporting awareness in global teams. At the same time our findings suggest that there might be a gap between research and practice that is interesting to further explore. We suggest future research in the field of computer supported cooperative work (CSCW) to seek an understanding of why the suggested awareness technology is not used in practice.

In conclusion, it is worth noting that the focus groups conducted were acknowledged for being useful means of identifying and discussing the challenges in sharing the knowledge across sites. A list of suggestions proposed by participants was compiled at the end of each workshop and used to plan the further improvements.

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