

SUPPORTING AWARENESS IN ASYNCHRONOUS COLLABORATIVE ENVIRONMENTS

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Abstract: One of the major challenges in asynchronous collaborative environment is to provide a sense of awareness of other users actions. The amount of awareness needed varies due to specific roles users undertake during collaboration. While emphasizing the importance of roles, this paper discussed awareness-role relationship and proposed a role-based approach to specifying the awareness characteristics in asynchronous collaborative environments. An example of implementation of role-based awareness supporting system LiveNet4 was also illustrated at the end of this paper.

1 INTRODUCTION

Information that users have about each other's activities is commonly called *awareness information* (Drury 2002). Awareness is important for effective collaboration and coordination. It helps people know who else is doing what in a shared workspace.

Jill Drury and Marian G. Williams summarized a large number of definitions for awareness. Among them, the most referenced definition of awareness is defined as "an understanding of the activities of others, which provides a context for your own activities" (Dourish 1992). Group-structural awareness is described as "knowledge about such things as people's roles and responsibilities, their positions on an issue, their status, and group processes" (Gutwin 1996). Gutwin and Prinz both gave the definition of social awareness: "the understanding that participants have about the social connections within their group" and "information about the presence and activities of people in a shared environment" (Prinz 1999). Prinz also described task-oriented awareness as "awareness focused on activities performed to achieve a shared task". Workspace awareness is defined as "the up-to-the-minute knowledge of other participants' interactions with the shared workspace" and "who is working on what" in (Gutwin 1995) and (Vertegaal 1997), respectively.

These definitions describe awareness in collaborative environments from different point of view. Few

of them explains the dependent relationship between awareness and role. For instance, the first definition of group-structural awareness "knowledge about such things as people's roles and responsibilities, ..." (Gutwin 1996) suggested granted roles as a kind of awareness information, but did not reveal their deeper relationship.

Despite diversity of functionality and appearance of collaborative environments, there always have four key aspects in collaboration: people, artifact, action and activity.

- People is the subject of an action while artifact acting as the object.
- Actions performed by people are restricted by their assigned roles.
- Activity is the place where people acts on artifact.

Their relationship can be described as people with roles aiming at goals act on artifacts in an activity. Artifact is considered as input and output of people's action. Activity is a space containing people with roles, artifacts and their action relationships (Gao 2003).

A collaborative environment may consist of several activities, with each other which containing role-taking participants, artifacts, and even sub-activities, as illustrated in Fig. 1 (a). Usually there are two kinds of artifacts involved: an artifact containing follow-ups is called a container artifact, like a meeting, a calendar, a file folder or a discussion forum; a simple artifact contains no other artifacts, like a URL, a text file

or a documentation. An activity is treated as a special container artifact. In this paper, activity is chosen as an analysis unit for awareness supporting. Given it is common that an artifact is shared by multiple collaborative activities, copied artifact link is allowed for information sharing. Detailed information about the activity, role, artifact, participant and their relationship can be found in (Gao 2003).

Different roles have different awareness requirements. For instance, in a software development project, a project manager needs to be aware of each task's progress, milestone achieved, and major changes made. While a general member may only need to know the task assigned to him and changes made relevant to his/her task.

Therefore, to determine who should know what, firstly we need to define an awareness information space for each activity, resolving "what to know" problem; secondly apply role restrictions on this awareness information space to produce sub-space for each specific role, resolving "who know what" problem.

In this paper, we focus on supporting awareness for role based asynchronous collaborative environment. Whilst emphasizing the importance of roles that people take on, we analyze related work on awareness, then proposes a role-based approach to specifying the awareness characteristics. After that, relationships between awareness, role, and awareness information space are discussed. A real system implementation of this approach is illustrated at the end of this paper.

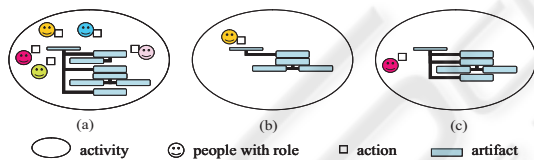


Figure 1: An example of activity (a) An activity with roles and artifacts (b)(c) Different roles have different views of activity

2 ROLE-BASED AWARENESS

Knowledge of an activity comprises information about all the artifacts, people, roles and their relationship, including

- knowledge of participants involved in activity
- knowledge of artifacts manipulated in activity, and
- knowledge of roles' responsibility in activity

The first part represents people aspect information, such as who is taking which role and where participants are. The second part represents artifact aspect,

such as which artifact is manipulable, and who has made what changes and when. The third part describes the dependent relationship between role and action, such as which action is permitted by which role. All the activity specific awareness information composes an information space, called *the awareness information space* of this activity, denoted by H_S (See Fig.2 (a)). Awareness information space H_S is a set.

Given diverse awareness requirements depend on diverse roles, a role-based awareness that defines one role has of another role is described as follows:

Definition 1 Given two roles R_i and R_j in an activity of an asynchronous collaborative environment, if R_i has the knowledge of R_j 's activity, we say role R_i has the awareness of role R_j in this activity.

Similarly, knowledge of role R_j 's activity comprises information about R_j 's group people, manipulable artifacts and R_j itself, as listed below.

- knowledge of participants involved in R_j
- knowledge of artifacts under R_j 's control
- knowledge of role R_j 's responsibility in activity

The first part specifies who is taking role R_j . The second part contains artifacts that R_j can manipulate and relevant changes made by whom at what time. The third part describes what actions are permitted under R_j . All the awareness information composes an information sub-space, called R_j 's awareness information space in this activity, denoted by H_S^j . It is easy to prove that H_S^j is a subset of H_S .

Assuming H_S is a countable set, we can obtain role R_j 's awareness information space H_S^j by applying R_j -specific mapping on H_S , as shown in Fig. 2 (b)(c).

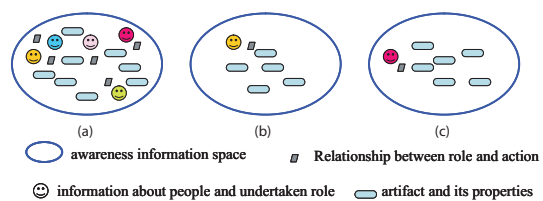


Figure 2: An awareness information space H_S and two sub-spaces (a) awareness information space H_S (b)(c) two sub-spaces of H_S

2.1 Complete and partial awareness

It is possible that role R_i has complete access to role R_j 's awareness information space H_S^j , or has partial access to it. The definition of role R_j determines the

dimensions of H_S^j , while the definition of role R_i limits the access dimensions of R_i to H_S^j . Here we borrow two terms from (Drury 2002) to describe these two kinds of awareness:

Definition 2 Given two roles R_i and R_j in an activity of an asynchronous collaborative environment, if R_i has a complete access to R_j 's awareness information space H_S^j , we say role R_i has the complete awareness of role R_j in this activity.

Definition 3 Given two roles R_i and R_j in an activity of an asynchronous collaborative environment, if R_i has a partial access to R_j 's awareness information space H_S^j , we say role R_i has a partial awareness of role R_j in this activity.

It is also possible that role R_i has no access to H_S^j , which is an extreme situation of partial awareness. In this case, we say role R_i has empty awareness of role R_j in that activity.

Each awareness can be obtained by set operations on role R_i 's awareness information spaces H_S^i and R_j 's awareness information spaces H_S^j . Fig. 3 (a) represents complete awareness if set H_S^i and H_S^j are equal, namely $H_S^i = H_S^j$. Fig. 3 (b) illustrates how partial awareness is obtained if intersection of H_S^i and H_S^j is not empty, namely $H_S^i \cap H_S^j \neq \emptyset$. If the intersection is empty, as shown in Fig.3 (c), role R_i and R_j have empty awareness of each other, namely $H_S^i \cap H_S^j = \emptyset$.

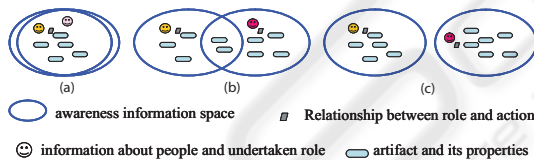


Figure 3: Complete and partial awareness represented by awareness information spaces (a) Complete awareness (b) Partial awareness (c) No awareness

2.2 Relationship between role and awareness information space

Before discussing relationship between role and awareness information space, we assume participants undertaking the same role have the same awareness needs. If people with different roles have an equal awareness information space, it suggests the definition of roles might not be appropriate from information management point of view because they do not differentiate from each other. In reality, it is almost impossible to have two equal awareness information

spaces existing in one activity. However, if overlapping is more than, say 90 percent, it also suggests some potential role definition problems.

One way to differentiate one role from the others is to refine its role responsibilities. For instance, three teachers undertake the same teacher role in a course delivering activity and their routine tasks are not totally the same. Teacher A is in charge of delivering lecture; teacher B is a lab instructor and teacher C is an on-line instructor and assignment marker. Obviously their awareness information spaces should not be defined equally. A good solution can be refining the teacher role into three separate roles, for instance, lecturer, tutor and marker. Clear and precise definition for role responsibilities and awareness information space boundaries is important for efficient collaboration and coordination.

On the contrary, several roles can be merged to a new role if their awareness information spaces need to be expanded. For instance, an assignment marker and an exam marker can be taking an assessor role to access the expanded awareness information space.

A new role can also be created if access to intersection of several roles' awareness information spaces is necessary and no existing roles currently satisfy the demand.

So far we have discussed role-based awareness, different awareness types and relationship between role and awareness information space. One more thing still needs to be clarified: how the information within awareness information space is reflected and utilized in an activity, for instance, what sort of tools or functionality should be implemented for awareness support?

We constitute a general specification for role-based activity in asynchronous collaborative environment as follows:

- Show the changes being made
- Show the historical changes made
- Show the time of each historical change and corresponding contributor
- Show people' identities and roles
- Show area viewable by each role
- Show the artifacts being manipulated and their responsible roles

3 AWARENESS SUPPORTING IN LIVENET4

A number of features that explicitly address the above awareness specifications have been implemented in LiveNet4, a role-based workplace network for the collaborative knowledge sharing.

The major awareness features implemented are:

- **Activity summary**

Activity portal after login provides a summary of activity information, including numbers of involved roles, participants, artifacts and recent update time.

- **Change reminder icons**

Any changes of artifact result in a corresponding reminder icon (eg. new or updated) attached with the titles of itself and of all the upper level container artifacts.

- **Activity notification**

It is an optional feature used to configure personal account to have activity notification active or inactive via email. Notification filter can be set for the whole activity or for some particular artifacts in the hierarchical artifact structure.

- **People login status**

At the lower left corner of LiveNet4 activity page, there is a participant list displaying who is currently logging in. To exploit awareness, a synchronous **chat room** is also provided. The right part of activity page displays the viewable artifacts by a login role.

- **Forum discussion**

People can create threaded discussion area. Each posted message is in text format, with its contributor and creation time.

- **Calendar**

People can create a personal calendar or a group calendar as critical date reminder. It can provide an overview of all the relevant artifacts created on a particular date or during a given period, for instance, within a day, a week, a month or a year.

- **Search and sort**

A search facility is provided to find viewable artifacts quickly within an activity. Artifacts can be sorted on type, name, contributed or modified time.

Detailed information about the component-based architecture of LiveNet4 and Model-View-Controller implementation on J2EE platform can be found in (Gao 2003) and its relevant references. Because of the page limits, full screen shots could not be provided here. Interested readers can try the LiveNet4 system at <http://livenet4.it.uts.edu.au>.

4 DISCUSSION

This paper analyzes awareness needs for asynchronous collaboration, specifying the dependent relationship between awareness and role, giving the descriptions of role-based awareness, awareness information space, and complete and partial awareness. Role can be refined or merged by checking different roles' awareness spaces. Specifications of awareness information inside of awareness information space H_S are also suggested. Based on the role-based awareness,

several supporting tools are implemented in collaborative environment LiveNet4.

Given the awareness needs are analyzed from the basic aspects of collaboration, the role-based mapping approach can be extended to synchronous collaborative environment with little revision. For instance, the awareness information space for synchronous application should also contain synchronous operation information, such as who is using which tool doing what.

For a given collaborative environment, a role's awareness information space is a projection of H_S restricted by the role definition. Changes of role responsibilities result in the corresponding dimension changes of awareness information space. More awareness information can be provided by defining a loose role. Similarly awareness information can be refined by defining a strict role.

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