Is Group-Awareness Context-Awareness?

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Abstract. Group awareness correspond to an important concept on Groupware applications, allowing individual users to be kept aware of group's activities and status. Similarly, on Pervasive Computing, context is defined as any relevant information that can be used to characterize the situation of an entity [7]. In this position paper, we advocate that group awareness information should be considered as context information and handled as such. Group awareness information is often employed for decision making, contributing to users' activities and decisions. It represents also an important clue about user's context, characterizing individual's actions regarding the group. As such, group awareness may be used for adaptation purposes, adapting the system behavior, the supplied content or its services. To illustrate this point, we discuss the use of a context distribution system as a group awareness distribution mechanism.

Keywords: Group awareness · Context-awareness · Groupware applications
Context-aware applications · Context distribution
Pervasive Information Systems

1 Introduction

Group awareness is a well-known concept from Groupware Systems. It refers to the knowledge group members have about the group and its activities (past, present and future activities) [8, 12]. This information is commonly used for helping decision making, since it promises to group members a common context for their own activities inside the group. Presenting this information offers an important knowledge about the current status of the group, allowing group members to better evaluate the relevance of their own activities for the group and its goals.

A similar concept exists on Pervasive Computing: the notion of context, which is defined as any information capable of characterizing the situation of an entity [7]. This information, that often refers to physical and execution environment (e.g. user's location, device available memory, network connection, etc.), is traditionally applied for adaptation purposes. Context-Aware Systems [1, 7] observe it in order to adapt accordingly their own behavior. They perform adaptation tasks in the behalf of the user in order to propose her/him the most appropriate service or content.

Both notions can be seen as an information capable of characterizing user's interactions, individually or as a group member, but their treatment is not the same. For group awareness, the focus is on delivering this information to the user, while on

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context awareness the focus is on adapting the system behavior in a transparent way. Even on mobile Groupware Systems (e.g. [11, 21]), these notions are distinguished and handled separately: the first is delivered to the user, while the latter is used for adaptation purposes. However, group awareness information offers an important clue about user's context, characterizing individual's actions with regard to the group and its status.

In this position paper, we advocate that group awareness information should be considered as context information and handled as such. By considering group awareness as context information and giving it a similar treatment, we may reach a more dynamic and proactive behavior on groupware systems, offering applications that may adapt their behavior (content and services) to current usages and technologies, as well as to the group and its activities. To illustrated this point, we discuss the use of a context distribution mechanism for distributing both group awareness and context information among group members according their current context.

This position paper is organized as follows: Sect. 2 discusses the notion of group awareness and its treatment on Groupware Systems, while Sect. 3 introduces the notion of context and its application on context-aware applications. In Sect. 4, we discuss similarities and dissimilarities between both concepts. In Sect. 5, we illustrate this discussion with a context distribution mechanism, before concluding in Sect. 6.

2 Group Awareness on Groupware Systems

The term group awareness refers to actors' taking heed of the context of their joint effort, to a person being or becoming aware of something [19]. It is defined as an understanding of others' activities, which provides a context for our own activity on a group, allowing evaluating individual actions with respect to group goals and progress, and assuring that individual contributions are relevant to the group's activity [8]. This relevant concept of Groupware Systems allows to transform irregular interactions of group members into a consistent and perceptive performance over time [18].

Group awareness information is mainly considered from a 'knowledge management' perspective. It represents a knowledge that has to be externalized and made visible to group members, offering a common basis in which members' individual actions take place and gain a meaning. This knowledge is necessary for a better understanding of the individual's activities and group status. Through this knowledge, group members dispose of a better perspective for their own activities, being able to evaluate their relevance for the group itself. As a result, group awareness mechanisms may contribute to reduce common coordination problems, preventing problems due to a lack of knowledge about group activities (e.g. double work, unfinished or delayed tasks, etc.). This knowledge is used for decision making, allowing each group member to place her/his own contribution on the context of the group.

Literature proposes different group awareness mechanisms [3, 11, 12]. Works, such as [9], point out the contribution of these mechanisms to successful group work. They also demonstrate that inappropriate mechanisms may have a disruptive effect on group work, disturbing users on their working tasks. A challenge is then to propose group awareness information while preventing the risk of an information overload. Since this

information is directly proposed to the users, this risk increases with the volume of available information, leading group members to spend more time assimilating it than performing their working tasks. Several mechanisms tackle this issue through filtering or appropriate user interfaces [3, 12]. Whatever mechanism is adopted, the main ambition remains: to make available to group members information about the group itself, its activities (current, past or future) and its status, in order to help these members to better coordinate their own actions considering group goals and situation.

3 Context Information on Pervasive Computing

Similar to group awareness, the notion of context denotes a large concept. It is often defined as any information that can be used to characterize the situation of an entity (a person, place, or object) that is considered relevant to the interaction between a user and a system [7]. Multiple elements can be considered as context information, even if this definition delimits those to the boundary of a computing system. Defining what elements could be considered as context on a given system implies identifying the entities that can be observed and the relevant information about these. Different elements are cited in the literature [13], including information about the physical and the execution environment (e.g. user's location, device memory and network connection).

Independently of these elements, the purpose of observing context information remains the same. Context-aware applications consider it in order to adapt their behavior according to context changes, aiming at increasing their usability and effectiveness [1, 7]. The final goal is to improve the user's satisfaction in a transparent way, offering her/him the most appropriate service (or content) according to changes on the observed context. The user does not necessarily need to be aware of any adaptation performed by the system. It is up to this later to adapt itself to the user and her/his context, without an active intervention from this user.

This transparency is a key element of context-aware systems, for obtaining more adapted and proactive software applications. Thanks to different adaptation mechanisms, these systems may apply context information for adapting content [11], services [16], internal composition [10] or deployment [5]; they may even anticipate user's requests, offering a proactive behavior [16]. Nevertheless, the success of such adaptation mechanisms depends on the context information that guides them. The richer is the observed context information, the richer these mechanisms might be.

4 Common Aspects and Divergences

Dourish [8] defined group awareness as "an understanding of the activities of others, which provides a *context* for your own activity. This context is used to ensure that individual contributions are relevant to the group's activity as a whole and to evaluate individual actions with respect to the group goals and progress". Supplying group awareness information may offer users the necessary knowledge for creating an implicit coordination mechanism, by improving understanding about the relevance of their own

activities to the group. We may thus expect better results for the group as a whole since each member is aware of the group overall situation.

Group awareness offers then a *shared context* for the group and for our own individual activities on it. Since its definition, group awareness can be seen as context information. It represents a knowledge referring to the organizational context in which the cooperative work takes place [11]. It participates on the user's context, by placing the individual as part of a group.

Inversely Kirsh [14] points out that "context is a highly structured amalgam of informational, physical, and conceptual resources that go beyond the simple facts of who or what is where and when to include the state of digital resources, people's concepts and mental state, *task state*, *social relations*, and the *local work culture*". In other terms, context information could (or should) include collaborative elements, describing the social environment in which user's actions take place. This notion is not limited to physical and execution elements as often on Pervasive Computing. Authors such as [11, 15] have considered organizational elements, such as the notion of group or role, on their context models. By considering those, they enlarge the notion of context usually adopted on Pervasive Computing, considering users as part of a group.

Both definitions (group awareness and context information) point towards the notion of context, since both can be used to characterize user's actions when interacting with a given system. Because a user is not anymore considered as an isolated individual, and that the interaction between this user and her/his group is mediated by a system, group awareness information becomes context information, since it becomes relevant for the interaction between this user and the system. Information about the group and its status (i.e. group awareness information) may affect user's needs considering the system and then influence the way this user might interact with the system.

Nevertheless, group awareness information is not handled as context information on Groupware Systems, and inversely, Context-Aware Systems often ignore collaborative aspects involving the user. Even if the first have evolved and are now confronted to pervasive environments, the treatment of group awareness information has not fundamentally changed. Conversely, the later, as noted by [6], have focused mostly on the context of a single user, so the context of multiple users involved in a common endeavor remains unexplored. These systems, in their majority, consider users as individuals, ignoring the effects of the group on the individual's activities.

Works on mobile Groupware System often distinguish group awareness from context information, the latter being used for adaptation purposes, while the former is somehow proposed to the user. On [11] authors proposed to filter group awareness information according the user's context. Even if concepts from group awareness (e.g. group, activities and role) are considered as context information, group awareness information is handled separately. On [21], even if execution context is considered for proposing group awareness widgets, authors discard a pure automatic adaptation, such as in context-aware applications. On [15], context information includes group related information, but it is used for deriving process adaptation, and not proposed to users. Similarly, on [4], traditional group awareness information is analyzed as context information, but the purpose remains making it explicit and guiding the design process, without yet considering physical and environmental influences. Authors on [6] consider the notion of group when conceptualizing the notion of context of use for adaptation

purposes. Unfortunately, this conceptualization is not clearly associated with group awareness supply, leaving it to its traditional purposes of helping user's decision making. Even if conceptually some authors are relating context and group awareness concepts [4, 6, 15], these approaches are often limited to modeling issues. Advances on context management and context-aware systems architecture (e.g. [1, 5, 10, 13]) do not seem yet to benefit Groupware Systems architecture. Those remain dealing with both separately: acquisition, modeling, storage and treatment of both are separate, complexifying an architecture that is already enough complex.

Another aspect distinguishes the treatment of context and group awareness information: their dynamicity. Context information is characterized by its dynamicity, evolving with environment changes and user's movements [20]. When managing context information, a system must consider it as something that will evolve potentially quickly [13]. Such dynamicity also affects collaborative aspects of the user's context [15, 17]. As pointed by [17], context in a design work process has a dynamic nature, new events appear and new decisions are taken, modifying its flow. Dynamicity is then part of the notion of context as a whole. However, when considering group awareness mechanisms, this concern is not necessarily a priority, except for mechanisms dealing with workspace awareness (e.g. [3]). These mechanisms use to deal with real time interactions, making the dynamicity of the observed information a key aspect for their success. For other mechanisms, the dynamicity of group awareness information is not a priority. Evolution and dynamicity of group awareness information do not receive the same attention that changes on the execution context.

For us, clearly associating group awareness and context information is assuming that both can be used for decision making and for adaptation purposes. It is assuming that Groupware systems may adapt their behavior according to group awareness and context information in a transparent way (i.e. without an active intervention of the user), and that any context-aware system may consider users not only as individuals. Considering group awareness information as context information is also assuming its dynamicity, assuming that groups and their situation may evolve according members' activities and that dynamicity is a 'first class' characteristic of group awareness information too.

5 Illustration: Distributing Group Awareness Information

In order to illustrate the feasibility of judging group awareness information as context information, let us consider the case of the context distribution, which is defined as the capability to gather and deliver context information to interested entities [2]. Context distribution mechanisms are necessary to organize the distribution of context information, since the success of a context-aware system depends on the availability of this information, often disseminated over the network [20]. Similarly, Groupware systems must also consider the distribution of group awareness information over the network, making it available on each node used by a group member. Considering group awareness as context information allows considering a single distribution mechanism

for both, which contributes to reduce the complexity of Groupware systems, notably mobile and context-aware ones, which are confronted to the complexity of collaborative aspects and of context management tasks.

Let us consider the context distribution mechanism proposed by [20]. This context-based grouping mechanism organizes groups of peers based on a criteria set and a dissemination set (i.e. which information can be shared in the group). A context group G_D is defined as follows [20]:

$$G_D = <C_D,\ I_D>,$$

where C_D is the criteria set, i.e. set of context elements determining the group, represented in a query according the context model; and I_D is the dissemination set, representing the context information to be shared among group members.

These groups can be statically predefined or discovered based on contextual characteristics shared among members of the group [20]. The group definition, called template, remains stable over the time. However, since it relies on context information, it is naturally dynamic. This template is used to instantiate a group: the query representing the group criteria is processed with the current values of the corresponding context elements forming a concrete contextual group. As context changes, values corresponding to the group criteria are updated, changing the group composition since members may leave the group instance and integrate another one. Moreover, each group member constantly updates other members about new values on its dissemination set, keeping them updated about context changes on this set.

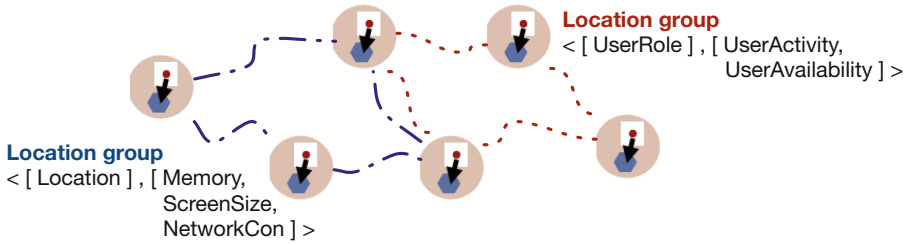

Fig. 1. Example of two group templates for context distribution inspired by [20].

The group can be seen as a neighborhood [20] that is semantically defined by the application: nodes in the same network, nodes in the same location, nodes executing over similar devices, nodes acting on behalf of users playing a given role, etc. For instance, on Fig. 1, two groups are defined, one based on the location (devices sharing the same location), and another based on the notion of role (users sharing the same role). On the first group, information concerning the execution context is shared among group members, while on the second, information about the user's activities is shared. The first group can be used in GDSS, such as [21], for adapting application deployment, using nodes with better interaction conditions (more available memory, better screen size and network connection). The second concerns availability awareness,

informing users about the availability and the activity of nearby colleagues playing a similar role. This offers interesting clues for opportunistic interaction among group members, useful, for instance, on supporting maintenance tasks, such as mentioned on [15].

By considering group awareness information as context information, this first may benefit from context management. Group awareness information contributes to context data, as any other source of context information, and is distributed using the same context distribution mechanism. No extra mechanism for distributing group awareness information is needed. Moreover, the same information can be used for adaptation purposes or for helping decision making, in a very homogenous way.

6 Conclusions and Perspectives

On this position paper, we advocated that group awareness information should be considered as context information and handled using similar mechanisms. We discussed similarities between these concepts, which lead us to consider that group awareness as context information about the group and its status. We also discussed the differences on their treatment and illustrated this idea through a single context distribution mechanism distributing both for different purposes (adaptation as well as decision making).

In our opinion, the convergence between group awareness and context information is needed for better supporting Information Systems (IS) of tomorrow. With the growing evolution of information technologies such as smartphones, network connections or IoT, Information Systems are not anymore limited to the boundaries of their organization, integrating the actors' mobility and the physical environment. They are evolving into Pervasive Information Systems (PIS) [16], in which context-aware applications and groupware systems will play a key role. More than never collaboration should be supported appropriately, considering moving and dynamic environments. Adaptation to this changing environment and supporting group activities are essential for tomorrow's organizations. Information Systems themselves should become more proactive and adapted to its users and their needs. For successful Pervasive Information Systems, context-awareness is necessary, and in particular context-aware groupware applications, capable of adapting their behavior to any changes on the user or group context. This means applications that are able to consider group awareness information as part the user's context. Actors on any modern organization cannot be considered anymore only as individuals, they must be considered as part of the organization. Integrating the concepts of group awareness and context information as a single concept that must be handled transparently and homogeneously on any Information Systems is a key aspect for successfully transforming these systems on Pervasive Information Systems.

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