Approach for Enriching Distributed User Interfaces with Awareness

Montserrat Sendín
GRIHO: HCI research group, University of Lleida
69, Jaume II St., 25001- Lleida, Spain
msendin@eps.udl.es

Juan Miguel López
College of Engineering,
University of the Basque Country
Nieves Cano 12, E-01006 Vitoria, Spain
juanmiguel.lopez@ehu.es

ABSTRACT
Last technological advances have brought drastic changes affecting the way interactive systems are conceived. Designers have to tackle the fact that UIs could be controlled by multiple end users on diverse computing platforms in assorted environments. Novel UIs enable end users to distribute any widget and piece of information across different contexts. However, these kinds of facilities acquire an added value when they are ruled by the well-known awareness. It is necessary to devise new mechanisms to support distributed UIs flexible enough to deal with the diversity of contexts and group concerns. Presented work provides a series of contributions in DUIs support, with respect to introducing awareness.

Author Keywords
Distributed User Interface, Awareness, Plasticity, Context

ACM Classification Keywords

General Terms
Management, Design.

INTRODUCTION
Distributed User Interfaces (DUIs) enable end users to distribute in time and space any widget and piece of information across different contexts. Thus, designers have to tackle the fact that user interfaces (UIs henceforth) can be controlled by multiple users on diverse computing platforms in assorted environments. The need of introducing and supporting work in group becomes obvious. It is necessary to devise new mechanisms to support DUIs flexible enough to cope with the increasing diversity of contexts and able to deal with group concerns.

DUI development has been a research area of interest in recent years. As relevant works in this field we can mention a few. Thus, [5] proposed a reference model for DUIs that examines them according to four dimensions: computation, communication, coordination, and configuration. It is called 4C framework for DUI. The work by [4] provides a system of interaction with multiple surfaces creating an environment for collaborative work. The UI is physically distributed over heterogeneous platforms, being reconfigurable dynamically allowing agents to migrate from one platform to another. In [8] a software tool for rapid prototyping of interactive systems is introduced, allowing UIs being distributed. This system provides designers with a means for generating ideas about how a UI can be distributed in a context of use, and also helps evaluation. Penichet et al. [10] present a novel approach and a methodology to gather requirements for groupware applications. Luyten et al. [7] present a task-centered approach to develop DUI for ambient intelligent environments based on the model-based approach. To support situated tasks distribution and context influences they introduce an environment model.

Except the work of [10], all of these approaches are mainly centered on physical characteristics of DUIs, but they do not consider awareness elements. It is long recognized that successful group work is not simply the union of individual tasks, but an organized set of coherent activities with good strategies of communication, cooperation and coordination among group members [1]. Awareness reduces the meta-communicative effort needed to collaborate across physical distances in distributed environments and promotes real collaboration among group members [9]. The integration of these aspects in the development of DUIs is not an easy task. An ideal infrastructure for DUIs should provide the capacity to adapt interactive widgets and data to each particular context regarding, among others, the working group.

In this paper we present how the guidelines and software approach defined in the Dichotomic View of Plasticity can be applied to support DUIs that also consider and integrate group awareness elements. The aim is to provide an infrastructure to deal collaborative tasks in DUIs with

1 Understanding of the others’ activities, which provide a context for the own activity [8].
little or no extra effort for the UI designer. Resulting
DUIs promote distributed interaction and real time
coordination among remote users, contributing to real
collaboration and a deeper understanding in multi-
environment distributed scenarios. These contributions
provide extensions to the previous infrastructure based on
the Dichotomic View of plasticity, trying to integrate
awareness in DUIs in an efficient and systematic way.

Next section explains abovementioned approach, taking a
concrete groupware platform as an example of how the
system works. Finally, some conclusions end the paper.

APPROACH FOR ENRICHING DISTRIBUTED USER
INTERFACES WITH AWARENESS

Software Infrastructure for Supporting DUIs

Terms as mobility, heterogeneity and adaptation are
important elements to be managed in DUIs. These
challenges are collected under the term plasticity. Our
approach, which is based on the Dichotomic View of
plasticity [11], reuses and specializes some already
existing plasticity tools to work in group. It consists in
integrating and exploiting awareness by an existing
infrastructure of plasticity, as an integral part that is
embedded in the adaptation process. In other words,
awareness information is incorporated in the
characterization of the context of use. As a result,
contextual information for these kinds of interfaces and
the subsequent adaptation are considerably enriched
and resulting interfaces provide the benefits from plasticity
and awareness jointly. Next, in this section, the process to
be carried out to provide awareness during execution,
without neglecting plasticity is presented. Then, the
system architecture operating in the server is described.

The first step to put in practice this approach is
embedding a specific Implicit Plasticity Engine (IPE
henceforth) on a given DUI on the client side. IPE is a
runtime adaptive engine to provide runtime adaptations,
and specific awareness mechanisms focused on promoting
collaboration that enrich the default operative in the client
side. Details on the software structure for the IPE,
specially detailed for components aimed at supporting
work in group can be consulted in [11]. However, we
would like to mention the most important component of
these kinds of components, the so-called particular
group-awareness –pGA in Figure 1-, which represents the
individual perceptions and particular understanding about
the group from each working group member. It includes
all the information generated during the performance of
the combined tasks that could affect to whole group state.
Additionally, it registers interactions of the user at hand
with the other group members and also any data related to
communication events and coordination actions.

Once the IPE has been embedded on the DUI at hand, we
can proceed with its execution. The information in the
particular group-awareness component will be kept
updated on the fly for further use. It can influence not
only to local decisions, but also the evolution of the
working group because each group member has to share
his/her individual understanding with the group, by means
of the server. In this line, the server gathers all the
individual perceptions in a common group memory
towards the construction of an overall perspective about
the group (the so-called Shared-Knowledge Awareness
[2] -SKA henceforth-).

The possibility of sharing all group perceptions makes
possible to deduce global properties, as well as suitable
considerations in benefit of the group. A reliable SKA
allows exploiting overall group constraints and
implications during the server inference process. Thereby,
the client is responsible for communicating to the server
any relevant change in the individual perception of the
group circumstances by sending a request. Figure 1 shows
the overview of the process described.

The server intercepts requests from group members and
filters information regarding awareness. Following
artificial intelligence foundations, it supports decision
making by means of an inference engine specially
prepared to derive some inferences about group constraint
combinations. Thus, the server applies the necessary
inferences in order to determine what adaptation is the
most convenient for being applied in the client-side,
according to the current group situation. During the
inference process certain global properties and suitable
considerations in benefit of the group can be deduced.

The results of the inference are returned to the group
members’ target platforms by a reply expressed as a set of
adaptations in conformance to the global properties
obtained, which are finally executed in the client.

Figure 2 displays how the entire server component works.
In particular, the inference engine and the SKA conform
the so-called awareness manager - (b) in Figure 2. The
delivery system module -(a) in Figure 2- is in charge of
preparing and delivering DUIs without groupware
capacities, providing them with awareness elements.
Henceforth it is explained how it works.

Once target DUI application is uploaded in the system,
the IPE derivation tool proceeds to prepare it. First step is
instantiating the Implicit Plasticity Framework 2 –IPF in
Figure 2. As a result, a specific component for supporting
work in group is obtained. Then, the system prepares and
links this component together with the original DUI
application. The result is the expected IPE, that is to say,
the original DUI application now with awareness support
embedded on it. Then, it is registered and made accessible
in the repository of applications, so that the client is able
to download and install it.

2 A generic client-side application framework to obtain components for
supporting work in group by a simple process of instantiation,[11].
Figure 1. Overview of the adaptation process in collaborative scenarios under the DVP.

It must be taken into account that the system does not perform this process in a fully automatic way. The IPE designer conducts the instantiation process, according not only to application’s specific particularities, but also considering the adaptation requirements, the contextual information to be considered and finally the target computing platform or device where is being to be executed, completing thus a complete plasticity process. We are referring thus to a semi-automatic process.

Case Study
The entire infrastructure presented in this paper has been proved in a real case for a particular DUI. We are referring to Lucane, an open source groupware platform developed in Java programming language and designed with extensibility capabilities. This platform is based on client-server architecture, with the server being the responsible for the management of information among users.

In order to illustrate our approach in this case study we have selected one of the functionalities that have been incorporated to Lucane. It shows automatically in each involved group member’s Calendar the foreseen end date of a task introduced in the TODO-List by a particular group member, provided other members of the group are implied in this task. Then, when this task is completed, a new event is automatically introduced in the Calendar to visualize the effective completion of the task. In the line of introducing visual awareness components, the idea is to distinguish situations in which the completion date is posterior to the foreseen date –marked using a red colour-, from the opposite situation –marked using a green colour-, being both cases visible in the Calendar. The visualization of these events by the entire group allows knowing the evolution of the rest of the members in their particular assignments, thus promoting the communication and coordination among them.

In order to manage all of this information, the awareness manager has to generate a complete historical of finalized tasks for every member, what implies registering a complete log of each one of them. Once this information has been recorded, in order to encourage even more group members to complete their group tasks and to collaborate, we have introduced a distributed widget consisting in visualizing a ranking of what we have called level of compliance. By level of compliance we are referring to the personal compliance degree regarding the scheduled dates for tasks. The widget showing the level of compliance for each member is visualized in the main interface once the user accesses the system. The level of compliance is a global property inferred in the awareness manager that is distributed to each particular UI in each target platform. The management of this ranking related to the level of compliance helps to apply certain general considerations, such as rewarding the winner with certain privileges while using the system. This could imply an extra motivation and thus a benefit for the group. Moreover, as this kind of information is not related to user presence, it is appropriate independently of the real situation, that is, both in remote collaboration and face-to-face scenarios.

CONCLUSIONS
Generally speaking, work on DUIs is mainly centred on physical characteristics of DUIs, but not much attention has been paid to work in group concerns. DUIs can clearly be improved if they are ruled by awareness elements.

Presented approach supports adding group awareness capabilities to existing DUIs that do not handle work in group concerns in a completely transparent way regarding their core functionalities. Furthermore, the generic application framework and the infrastructure of the delivery system offer a certain level of systematization. Moreover, the application framework used in the instantiation process is independent of the underlying technology used in DUI development. Currently, it can operate both with Java developments and also with .NET based tools, considering both, mobile and desktop environments. Illustrated case study has been implemented in Java, and serves to prove the achievement of abovementioned advantages.

The approach, based on the dichotomic view of plasticity, follows a client-server distribution model, but instead of being server-centered, it provides a balanced strategy. This strategy can be synthesized by an operational balance between both sides, and the consequent reduction of networking dependences by providing two levels of awareness appropriately synchronized. We are referring to a trade-off between the degree of awareness and the network usage identified by [3].

As further work, we are preparing proposed solution to be applied in real peer-to-peer based platforms, in order to check its validity in these systems. In addition, we are currently evaluating how users manage a number of new group features added on Lucane using presented approach.
ACKNOWLEDGMENTS
This work has been partially funded by Spanish Ministry of Science and Innovation through TIN2008-06228 and TIN2008-06596-C02-01 research projects.

REFERENCES