Distributed User Interfaces

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CHI 2011, May 7–12, 2011, Vancouver, BC, Canada.
ACM 978-1-4503-0268-5/11/05.

Abstract
This document exposes the most relevant issues regarding the development of Distributed User Interfaces (DUIs) to present the specific features that are not covered by traditional development processes. A transversal approach to tackle these new aspects is also proposed. Therefore, the goal of this workshop is to promote the discussion about the emerging topic of distributed user interfaces, answering a set of key questions: what, when, how, why distribute a user interface among different devices.

Keywords
Distributed User Interfaces; Conceptual Framework; Pervasive Environment

ACM Classification Keywords
H.5.2 User Interfaces (D.2.2, H.1.2, I.3.6); Theory and methods; User Interfaces Management Systems (UIMS); Input devices and strategies.

General Terms
User Interfaces, Software Engineering

Introduction
The cost reduction of digital displays has encouraged their deployment almost everywhere. They can be found in both, indoor and outdoor environments. Actually, most of these displays are used as advertising

posters or as domain specific user interface of a purpose specific application.

However, mobile devices and communication infrastructures allow a new way of interaction with the surrounding environment. While mobile devices provide limited displays, communication infrastructures provide these devices with the capability to relate them to the environment. Therefore, there is enough evidence to think on futures scenarios where mobile devices take advantage of displays from the environment, or even from other mobile devices, to overtake their limitations. Thus, user tasks, which traditionally were performed on a single display, actually can be distributed on many of them.

Concepts related to DUIs

The literature exposes some basic concepts that are related to the conception of applications that exploit DUIs [1].

Multi-monitor usage
A single user using a single computing platform wants to distribute the UI across various monitors connected to the same platform. For instance, a dual display is supported when a graphic card expands the main monitor of a computing platform to two or more connected monitors.

Multi-device usage
A single user uses several different devices together, whether they are running the same operating system or not [2]. For instance, a user controls a music player running on a media center using a remote control running on a handheld Personal Digital Assistant (PDA) and/or on a physical device.

Multi-platform usage
A single user uses heterogeneous computing platforms, perhaps running different operating systems. Multi-device usage subsumes a multi-platform usage (since there are different machines) but the reciprocal does not hold: a user could use several computers (hence, multi-platform) that are similar (hence, no multi-device).

Multi-display usage
We hereby define multi-display as a combination of multi-monitor and multi-device usages [3]. A single user may distribute a UI across multiple monitors and devices simultaneously.

Multi-user
It represents an extension of the previous usages to multiple users concurrently [3]. In this case, one or many users may want to distribute parts or whole of their UI across several monitors, devices, platforms, or displays. For instance, in a control room setup, users may want to direct portions of a UI to other displays of others users depending on the context of use. When a multi-user interface is of concern, it is also typically used for supporting tasks that are allocated or de-allocated from one user to another one, such as in task delegation, task suspension and resuming.

Taxonomies for multi-person display ecosystems

The coupling of multiple displays creates an interactive "ecosystem of displays" [4], where the scale of the ecosystem and the degree of individual engagement are key factors to take into account.

The scale of the ecosystem
The scale of the ecosystem depends on the size of the largest coupled device itself. Displays can be classified from the users' visual angle and distance according their geometry in different scales [4]:

- The inch scale display: The Inch scale display is up to 3 cm long, can be seen from up to 40 cm away, and the vision angle is up to 4º; for instance, a Phone.
- The foot scale display: The Foot scale display is up to 35 cm long, can be seen from up to 70 cm away, and the vision angle is up to 28º; for instance, a Tablet/Laptop.
- The yard scale display: The Yard scale display is up to 1 m long, can be seen from 1m to 3 m away, and the vision angle is from 19º up to 53º; for instance, a Pub TV o Tabletop.
- The perch scale display: The Perch scale display is up to 5 m long, can be seen from up to 10 m away, and the vision angle is up to 28º; for instance, Town centre.
- The Chain scale display: The Chain scale display is up to 20 m long, can be seen from up to 50 m away, and the vision angle is up to 23º; for instance, blinking lights.

The nature of social interaction
Coupled displays may be used in many social situations. Thus, to distinguish different social situation, five categories of interaction and sharing were defined by [4]:

- One-one: This is the simplest case where two colleagues or friends exchange files.
- One-few: This is the typical presentation setting where a single presenter is addressing a small group.
- Few-few: This is the typical collaborative meeting setting where a group of people is interacting with the same system.
- One/few-many: The most frequent current use of very large displays is at open-air events where a small number of people control what is shown on the public screens.
- Many-many: In some systems many people can interact with the same public screens simultaneously.

A conceptual framework to develop DUIs

Regarding the particularities of DUIs, we suggest a transversal approach where UI concepts and characteristics of a DUI concerns the repartition of one or many elements from one or many user interfaces in order to support one or many users to carry out one or many tasks on one or many domains in one or many contexts of use, each context of use consisting of users, platforms, and environments [1]. Figure 1 depicts the model to follow.

To exploit DUIs, the conceptual framework, should take into account new ways of interaction.

Interaction techniques
The use of many interfaces by the same user requires new interaction techniques to keep users' control on the application. For instance, a key issue is the focus management on DUI environments.

Interaction metaphors
To take full advantage of these resources, the framework should also explore new metaphors that benefit from the possibility of controlling different interaction surfaces at the same time. For instance, in a music generator, two different interaction surfaces can be used to control de frequency and amplitude of the sound wave to be generated.

Conclusions
The goal of this workshop is to promote the discussion about the emerging topic of distribute user interfaces, answering a set of key questions: what, when, how and why distribute a user interface among different devices. The workshop includes a discussion panel that will promote the definition of a reference framework on DUI, taking the different contributions and the proposed conceptual framework as starting point.

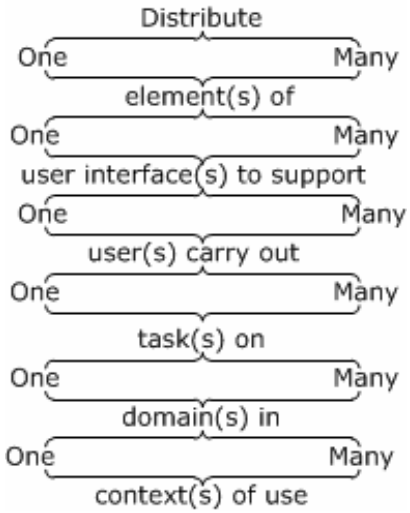

Figure 1. A transversal model of DUI.

Acknowledgements
We thank all ITEA2 Call 3 UsiXML, SERENOA FP7 and CDTI CENIT "mIO!" projects for supporting this research.

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