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Exploiting Context Histories: A Cross-Tool and Cross-Device Approach to Reduce Compartmentalization when Going Back

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Abstract: We propose an approach to support knowledge workers in going back to previously used information. This is achieved by exploiting usage context from interacting in ubiquitous computing environments and while being on the road. Going back includes information re-use in general as well as the resumption of open activity threads in order to proceed working on them. We consider personal information to go back to as well as information that has been shared in group contexts and present an implementation, the ContextDrive, in support of our approach. It consists of a distributed infrastructure and tools to acquire usage context and of a timeline-based search interface leveraging this context information in supporting users to go back.

1 Introduction

Finding and re-using information is a substantial and time consuming part of knowledge work. We focus on supporting users in going back to information related to their activities such as working on tasks, having a meeting, or traveling. Users are supported via the possibility to use rich context cues related to the respective activities in the search interface. The contexts of remembered episodes such as a meeting or a business trip provide many cues for going back to information then in use. These cues include physical location, people present, things going on at the same time, and immediately before and after a remembered event [T93]. Taking into account that for today's knowledge workers it is rather common to work on several activities in parallel, resulting in multitasking and interruptions, support in going back in order to resume a task or to find information to be re-used in general is an important issue. The results of a controlled experiment we conducted are in favor of our approach [P04].

Usually, the process of going back, e.g., to an uncompleted task in order to further work on it, is characterized by compartmentalization [BS00]. While cross-tool support for information re-use has been proposed in, e.g., [D+03], cross-device support is still an open field.

We propose a cross-tool and cross-device approach for going back exploiting usage context as a unified index of information use. We focus on supporting knowledge workers in ubiquitous computing environments who often use several computers to accomplish their tasks, either at the same time or consecutively (see figure 1). They often use, e.g., a laptop as the main personal machine but also other devices such as wall or table computers. In addition they might work while traveling.

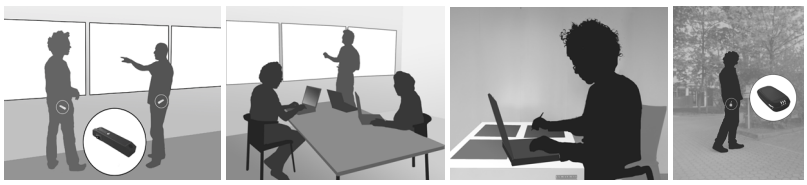

Figure 1. From left to right: a) Using RFID tags to detect group interaction at a wall display b) Use of public and personal devices at the same time in a meeting c) Personal use of two devices at the same time d) Using GPS loggers to provide outdoor location information

The goal of this research is to support such users in going back for re-use or resumption of activities by gathering usage context information to be leveraged as retrieval and visualization cues in the search interface (see figure 2). In the following, we present work in progress towards this goal.

2 Gathering Context Information

We developed components for acquiring and storing *informational* (What does a user do at a computational device?), *activity* (To which activities relate these interactions?), *physical* (Where is the user?) and *social* (Wo is with the respective user?) *context* for gathering context of personal information use as well as of group information use.

As the acquisition of informational and activity context needs to be done at the respective devices the users work with (laptop, wall and table displays, etc.), a distributed approach to context acquisition is required. The *Logger* gathers *informational context* information without the need for user input and is geared to make sparing use of system resources. The Logger logs Outlook email use, local as well as network file system access, and Win/Internet Explorer use. In order to trace file access, we use the win file system API like a virus scanner does. Furthermore it is recorded who is logged-in at which computer. According to our experience, context acquisition needs to be as implicit as possible without hampering the user. As system guesses on a user's current activity are often error-prone and due to results of our and other recent studies [P04, K03], we make an exception with respect to giving users the opportunity to indicate on which higher-level activities they are currently working, such as projects or writing a report. The *WorkingOn* module implements an activity list with a standard Windows look&feel and provides users with the possibility to link their interactions with their current higher-level activities (*activity context*), based on minimal user input, where multiple list items can be activated at the same time.

Beyond going back to personal use of several computers, going back to information used in group work is also to be considered as illustrated in figure 1 (a, b). When people gather for a face-to-face meeting, this often results in a multi-computer setup used in support of the meeting, e.g., laptops and a public display. Humans perceive such situations as a whole, while current computer use doesn't really support that understanding resulting in a lack of support to go back to the respective user's view of the whole. For instance, a meeting participant may remember information shown on a public display at the same time when he was about to edit a presentation document. After the meeting, each participant should only have access to his personal information plus what was shared with him. We support going back to information used at public displays in meeting situations. Therefore, the Logger and the WorkingOn modules are installed on our public wall and table computers in meeting rooms and in the hallway, where the long range RFID tags are recognized, distinguishing people's presence or absence in a room/area. Login at public displays is via public logins.

Physical context information is gathered to support locations and accompanying people as retrieval cues. Indoor, we use a long range RFID system, where tags can be switched on and off. Outdoors, we use GPS receivers, which are worn with an antenna attached to a user's jacket.

The components acquiring and storing the informational and activity context information have been implemented in C# based on the .NET framework. The acquired usage context is stored into a database (SAP SQL Studio 7.4) on a server computer.

The communication between programs running on a client and the server-based context database is handled through a transparent client-side proxy and ensures that the communication passes firewalls to facilitate access while, e.g., a user works at home. The client-side proxy is a separate process running in its own thread and its purpose is manifold. It handles connection unavailability: First, by locally buffering acquired context data in files and automatically transferring them upon the server being available again. Second, it redirects queries from the search interface to a locally stored private view of the otherwise server-based context database. The respective user's private view currently can manually be stored on a user's personal machine, e.g., a laptop. Third, the SQL queries from the search interface are encapsulated into SOAP/XML-serialized objects and sent to the server via HTTP. Finally, beyond transparently connecting all of the client-local components to the central context database, the communication over the client-proxy works towards providing search interfaces also to PDAs that may connect to the personal client via Bluetooth. Currently, this is used to download GPS logs from a Bluetooth enabled receiver.

The purpose of the server-side proxy is first, to block access attempts to the sensitive context information database from any unauthorized client. Second, it checks the incoming data on format, amount and basic consistency before writing them to the database. Third, it ensures that users can only retrieve from the database what they are supposed to.

3 Leveraging Context Information

We think that time is the appropriate interface metaphor for going back, thus implemented in our search interface for presentation and browsing of results (see figure 2). The timeline-based interface can be understood as an integrated activity representation as also proposed in [G+03]. Compared to earlier prominent timeline-based interfaces for personal information management such as [FG96, R99], we focus on information use to go back to rather than information creation as these systems did. Going beyond the "Stuff I've Seen" system [D+03], we support physical context cues for going back. Finally, going beyond all of these systems, we provide a distributed infrastructure and tools to support integration of information used at several devices as common in ubiquitous computing environments.

The initial version of our search interface (see figure 2) was implemented using Flash. It is divided into a left part for entering search arguments defining the result set to be displayed and a right part displaying the current result set as well as facilitating to browse it and go back to information by double-clicking on the corresponding icon.

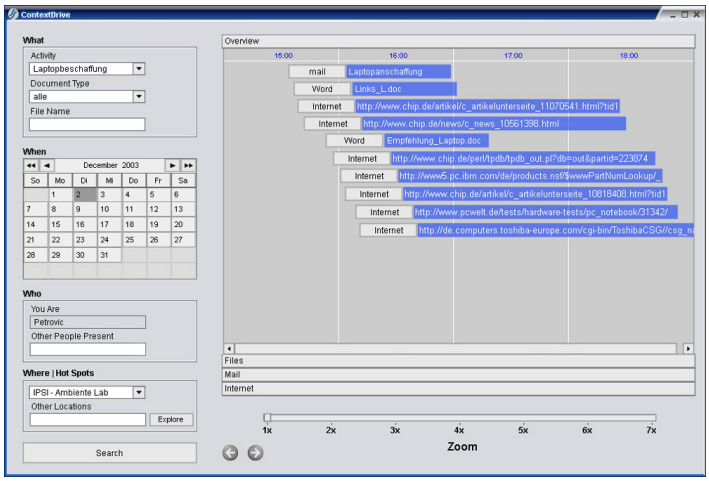

Figure 2: An initial version of our search interface

What: In addition to using file names as search parameter, it is noteworthy that the current activity list (see below) of the logged-in user is provided to support a user in going back to open activity threads. *When:* Time intervals can be defined. *Who:* The logged-in user filters the result set to be only from personally used and shared information. People that participated in a meeting or were present in the same room for other reasons can be used as search cues as well. *Where:* Hotspots like "at home" or rooms at the workplace can be selected. Additionally, the personal GPS context data can be associated with, e.g., city names for later retrieval.

4 Conclusions and Future Work

We have presented our approach and implementation for supporting knowledge workers in going back to information for re-use and for resumption of open activity threads. We are continuing to develop the system and interfaces in several directions as we up to now only leverage a fraction of the gathered context data.

5 Acknowledgements

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