

Personal information and the personal cloud

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Abstract

In the PIA project, a new approach to develop applications concerning personal information is proposed. It is based on the concept of a *personal cloud* that will provide easy and secure access to a variety of personal information from various devices and services. A semantic-based middleware that supports development of novel applications that can relate and combine personal information is the core of the personal cloud. The adaptive semantic middleware platform combines semantic web technologies, context or situation awareness, adaptive security mechanisms, and a high-level expressive programming model to support the development of applications concerning personal information. In this paper we will focus on the personal cloud and context awareness.

1 Introduction

A person can be in possession of a number of devices, like mobile phone, tablet, electronic paper device, PVR, notebook, stationary PC, gaming devices and entertainment center. Such devices may be connected in a personal network, and personal information is typically stored and used over the entire network. Personal information is also stored on external services available through the Internet and not controlled by the user.

Managing the personal information from various devices and external services can be a tedious and time-consuming manual task. Examples include selecting the right information, storing information on the required devices, ensuring information consistency, avoiding unnecessary redundancy, allowing sharing and cooperative work, and managing access control.

People interact, and one important way of interacting is to share information. Examples includes sharing photos from an event, co-operation in project work and sharing different entertainment media within a family. To make it easy to share information electronically and still maintain both the safety and the privacy of the information is surprisingly difficult.

Information is produced and consumed in a context, and this context can be used both to describe information and to find the correct and relevant information. In this paper we describe the framework for a personal cloud where context and user situation represent meta-data that can be used to relate and combine information to make information more accessible, and to increase the value and usability of the information.

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2 Context awareness

Context information, both about information units and users, is a source of information that can be used for identifying relations between information units, for information integration, for identifying topics or usage situations for a unit, and for associating units to users and personal clouds.

A frequently used definition of context is found in [3], where context is described as *any information that can be used to characterize the situation of an entity*. In our project, an entity will typically be an information unit or a user of information.

A variety of context characteristics may be used for relating information units and users to personal clouds. For information units such characteristics may include *who* the owner and/or user is, *where* and *when* the information was created/used, *what* the information is about and *how* information was used (e.g. as part of a presentation, as a personal note, etc.). Similar types of characteristics can also be used for expressing the context or situation of the user.

3 The personal cloud

There are a number of different, and not always coherent, definitions of a cloud and cloud computing [9]. In the *personal cloud*, the cloud abstraction is used to emphasize that personal information should be easy to use, accessible, scalable, and adaptable to various devices and user situations. In the PIA project, we thus define a personal cloud as *a pool of easily usable, accessible and reconfigurable virtualized personal resources*.

A personal cloud consists of resources, including information and services, owned by, available to or important for an individual. This information and resources may reside on his/her personal devices, be available on the Web, or be stored on corporate, organizational or private sites.

When accessing this cloud the user need not to know the location of its content or the details on how it is accessed. However, the user can provide details about her or his current context (e.g. location) to help determining what is the current most relevant or useful information.

From the perspective of a single user the personal cloud represents all resources he/she can access. This includes private resources, resources shared in the family, shared with friends, shared at work, shared in a specific project (possibly cross organizations), shared among members of a sport club or interest organization, public resources, health records, and more.

How the personal cloud is accessed is device dependent. From the application developer viewpoint a local proxy is the access point of the personal cloud. This local proxy will communicate with a local or remote service representing the personal cloud.

At a specific instance the user will only be using a few of the user's resources. What actually happens is that the user application, based on the current context, requests access to a set of resources. This request results in a negotiation phase between the application and the personal cloud service where this request is evaluated. Based on the provided credentials and specified policies such an access are granted or not. The application have to get acceptance from the user to access the resources on behalf of the user. This could happen when the application is installed and configured, or just before the negotiation phase with the personal cloud service (and then maybe only the first time).

Figure 1 shows a framework for a personal cloud consisting of a number of personal cloud services. A personal cloud service represents one resource or one information set

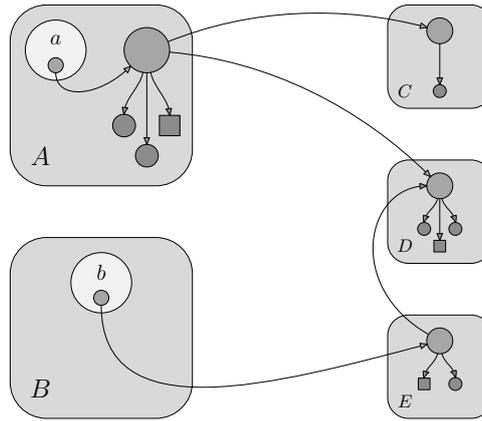


Figure 1: User application *a* and *b* executing in device *A* and *B* respectively. In application *a* the proxy is bound to a local personal cloud service. In application *b* the proxy is bound to a remote personal cloud service in remote server *E*. A personal cloud service can be bound to a series of other personal cloud services to provide access to the complete personal cloud of the user.

that builds the personal cloud of a user. In PIA it can be a native PIA implemented resource, an existing resource with a PIA mapping (for example a revision control system like Subversion), or a mashup of one or more such services.

A personal cloud will often include both private and shared information. The user has some information that he/she keeps for private use only, such as personal notes, email, private documents and images. Other information is important to and shared between a number of users, and is thus accessible in multiple personal clouds.

Related information may be seen as a cluster of information units, and can be managed as a compound unit to which certain properties can be associated. The framework provides controlled access to, update of, and sharing of information in the personal cloud, while ensuring consistency and security of information. The framework keeps track of logically related information, provides information about how different units of information relates to each other, and manages the information according to rules that determine access strategies, information correctness and consistency.

The framework provides the user with seamless access to all relevant personal information, where storage, replication and update strategies are determined by rules defined through personalization and situation- and context-awareness.

Flexibility is possible because of the adaptiveness of the middleware platform itself. The combination of the application, the involved devices, the available resources, and the user policy (profile) is used to determine the system components involved in providing the personal cloud and its services used to request, combine and maintain information and meta-data. This approach is strongly inspired by the service planning in QuA [4] and Argos [7], but also related to similar work found in [1] and [2].

4 Experiments and conclusion

In this early phase of the PIA project we conducted several experiments where applications or systems that can be build using the PIA framework has been developed without such a tool. These experiments included a context sensitive bus table [6], a context sensitive photo viewer [8] and a price comparing application using context information [5].

Alle experiments concluded that a framework like the PIA framework would gain

the development of such an application a lot. The integration of information from many different sources and the use of context are repeated and follows similar approaches in all these experiments. The suggested PIA approach is based on lessons learned from earlier project and these three student experiments.

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