The di.me User Interface: Concepts for Sharing Personal Information via Multiple Identities in a Decentralized Social Network

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Abstract. The di.me userware visualizes vast personal information from various sources and allows for sharing them in a decentralized social network. Multiple identities can be used to avoid unintended linkability when communicating to other users or external systems. The di.me user interface for that is presented in this paper. A user-centered information- and view-structure for items of the personal information sphere and concepts for multiple identities used for sharing are discussed.

Keywords: user interface design, decentralized social networking, personal identity management, security and privacy.

1   Introduction

Personal information is widely used for social networking and collaboration in business and private life. The project digital.me[1] researches on intelligent management of personal information and its use for social networking. A developed framework and system prototype – the di.me userware – shall integrate the personal information sphere by crawling and synchronizing data from various sources, e.g. files from personal storages and devices, profiles or contacts from external social networks. In order to achieve a high user control on personal data, the system architecture is conceptualized as a decentralized social network (Scerri et al., 2011), which allows to run *personal nodes* of the di.me userware either as self-hosted server or as user account on a provided server. Compared to o other decentralized social networks (Thiel et al., 2012), di.me follows an extended approach by providing intelligent features like context-aware recommendations, trust advisory (Heupel et al, 2012., in press), or rule-based automation of user tasks (Scerri et al., in press).

The personal information in di.me is represented by a set of *ontologies* (Scerri et al., 2012). Ontological knowledge is used to power the di.me semantic core in

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[1] `www.di.me-project.eu`

providing the automatic integration of distributed personal information, its improved management, as well as the recommendations and user advisory.

A specific approach of di.me is to provide *multiple, partial identities* (Pfitzmann, Hansen, 2010), that can be used to communicate or share information with other di.me users or external systems. For the design multiple-identity-systems, it is an important guideline (Hansen et al. 2008) to avoid linkability: Partial identities shall not be linkable to the same sender if not intended. In single-identity-systems, linkability risks are high as they support just one communication identifier, even if pseudonymized. I users want to have distinct identities in single-identity-systems, they must fall back to multiple user-accounts in the system (which e.g. Skype suggests[2]). In contrast, multiple-identity-systems link partial identities to a root identity. To technically enable continuity in communication, communication identifiers have to be used. In di.me, these identifiers are the "service-accounts" (for a discussion of service-accounts and anonymity requirements on the network level see Bourimi et al., 2012). Identities and claims in di.me are unproven, i.e. di.me does not act as an identity-provider. However, the integration of proven identities with anonymous credential systems was demonstrated (Schwarte et al, in press).

The di.me user interface (UI) is realized as web UI and a mobile Android client. The major challenge for the UI conceptualization and design presented in this paper was to find a flexible model that enables interaction the personal information sphere and to use them in a decentralized social network. A central research question was how to interact securely with the partial identities, and which concepts or metaphors for that shall be used in the UI.

2   UI Concepts for Personal Information and Identity

As social systems are highly developed, for many aspects relevant UI design patterns or established design solutions can be applied to achieve a self-explanatory UI. A prevalent pattern used in social systems are *groups of contacts* (see e.g. Crumlish, Malone, 2009) which resemble closed networks of people and allow the user to describe the relationship with individual contacts. This pattern was prominently marketed as added-value feature by Google+[3] ("circles") in 2011 (Simonite, 2011). Another example are "aspects" in the Diaspora network[4]. Groups strongly interplay with personal identity management, as groups can be used to control disclosure of partial information. The concept "group" may be simply a category of contacts of an individual user only or can be shared with others (Schümmer, Lukosch, 2007), e.g. for user management on centralized platforms. The group concept in OpenSocial[5], e.g. is a shared o centrally managed group for discussion forums.

The identity shown to others, often are called the "profile" (Crumlish, Malone, 2009), being the complete identity (Pfitzmann, Hanssen, 2010), i.e. the superset of all

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[2] https://support.skype.com/en/faq/fa829/
[3] plus.google.com
[4] diasporaproject.org
[5] opensocial.org

personal attributes which may be separated by privacy options. For *partial identities (sets of attributes)* that can be shown to others, different metaphors are used. In Microsoft CardSpace "cards" are shown which include attributes, potentially a certificate, and a recipient-specific, non-global identifier (Al-Sinani et al., 2010). The UI guides the user to select the same card for a recipient each time (Steuer et al., 2010). In the identity management of some providers of OpenID[6], attribute sets are presented as "personas". Users can manage personas, e.g. "work" with different attributes like e.g. nickname, or e-mail address. The term "persona" is also used by the Mozilla identity management [7] of web site credentials. "Identity" stands for attributes attached to the global identifier in the OpenID UI, probably indicating that the global identifier is the superordinate concept to "personas". A conflicting meaning of "identity" is used in a Mozilla Thunderbird extension[8]: Here, the attribute sets are called "identities", and they may be used within one email account. These and other examples may indicate that up to now, no common understanding and use of identity-related concepts has evolved within the UI-design for end-user applications.

Non-global communication identifiers are needed for continuity in communicating in multi-identity-systems. We consider them as less known to end-users, as many end-user-systems are single-identity-systems (even if offering partial sets of attribute). This may increase the difficulties of users with building up mental models of identity management systems (Sun et al, 2011). However, one case of multiple identifiers which is prevalent in end-user-systems are multiple email accounts. Email-clients like Microsoft Outlook or Mozilla Thunderbird offer selection of the account used for a message by a "From"-field in the UI.

3   The di.me UI for Personal Information and Identities

The di.me UI enables the user to interact with the personal information sphere and communicate via multiple identities. For that, a UI object model based on the semantic knowledge representations was developed and a view structure which focused on a web UI but also considered the adaption to the Android client.

They resulted from a *user-centered design process* with two major concept versions, each tested by a usability test: A first concept version was realized through a wireframe mockup without any visual design. It was tested in the first usability test. 21 participants from potential di.me user groups (private end-users and business users working with social system e.g. as public relations managers) worked in moderated sessions on predefined tasks. The method was a formative evaluation (Lewis, 2012). The qualitative results of observation, think aloud, and interviews were aggregated to categories considering the underlying causes of user problems (Dumas, 2003). Additional summative evaluation measures were used. Based on these results and further technical requirements, a second concept version was realized through a partly functional HTML-prototype with accurate visual design, and a functional Android client.

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[6] openid.net
[7] mozilla.org/persona
[8] addons.mozilla.org/thunderbird/addon/flexible-identity

It was tested in the second usability test with 20 participants, mainly private end-users. The methodology used was similar to the first test.

In this section, we present the UI concepts for personal information and identity, and qualitative test results related to that.

3.1   UI Objects

The object model defines the scope of information and the terminology applied in the UI, and by that plays a key role for the perception and usability of the system by the end-user. A specific challenge was to find object definitions that are appropriate to convey not only the proprietary functionality but also the information synchronized from external services. Besides the core concepts presented below, additional concepts were e.g. "Message", referring to direct communication messages to a contact or group, "Service" referring to the external systems that are being connected to a di.me personal node, or "Situation" which refers to a high-level description of the user's context for the context-related features.

The UI objects interplay with the semantic knowledge representation: They can be mapped directly to one of the domain ontologies, e.g. databoxes (see below) to the Privacy Preference Ontology (PPO) (Sacco & Breslin, 2012), or personal profiles to the Nepomuk Contact Ontology[9] (NCO). Therefore, a major role of the UI is to abstract the complex ontological knowledge under a simple and intuitive tool that can still enable users to take full advantage of the semantic core. In addition, the di.me UI also allows people to personalize some of the ontologies across the UI. For example, profiles can be customized by allowing users to extend NCO attributes and personalize how they describe themselves as an individual.

Objects for Personal Information Items. Personal information in the di.me domains cover two distinct types of concepts: Concepts that refer to personal information which identifies and describes the user as an individual; and concepts for user item collections, consisting of personal information items (such as documents, images, etc.). In the object model, this distinction is reflected in by the following concepts:

— *Profile card:* As central UI object representing personal identities the term "profile card" together with a card-visualization is used. It contains arbitrary numbers and selections of attributes describing the user, such as names, forms of contact, images, birth date, etc. Attributes are also modeled objects, as the user shall be able to re-use in several profile cards. Multiple profile cards may be used, potentially with different pseudonyms and non-overlapping sets of attributes. In the main navigation, the list of profile cards is labeled with "My Profile".

      Each profile card is either associated with information synchronized from a particular service (e.g. personal profile information from LinkedIn), or can be set up and extended freely by the user.

— *Databox:* A "databox" refers to a virtual collection of common information items that are typically shared by users. Databoxes can be used to categorize information items, and customized databoxes for individuals and groups can be created.

— *Data:* "Data" refers to a single informational item coming from the user's personal information sphere that can be identified in a file. This includes documents (e.g. PDF, doc, xls) or images.

Test results. In the usability tests, these concepts and terms were presented and discussed with the test participants. While no particular issues arose for 'profile card' and their attributes, the original wording "Information Sphere" for the list of data had to be changed because it was not self-explaining. It was renamed to the term "My Data" which, however, in the second usability study still was confused with the profile cards by some test participants. A suggested optimization was "My documents".

The term "databox" was self-explaining for most test participants. However, based on the information provided in the tests, the uni-directional sharing in databoxes was not clearly evident to half of the participants.

Objects for the Social Sphere. The following pair of UI objects describes the social sphere:

— *Person:* The object "person" refers to a contact of the user. Depending on the use scenario, the personal di.me nodes will retrieve persons from already existing databases, e.g. by synchronizing the user's personal data (e.g. email contacts, or contacts known through a service). The term "People" is additionally used as label in the UI for the main view.

— *Group:* Groups can either refer to a number of known persons manually defined by the user, a group of persons associated to an external service, or a group of persons suggested by the system depending on the current context (e.g. a group of nearby-people). A person can be assigned to many groups. Whether the popular concept "group" is sufficient to structure a user's social sphere appropriately was an important design question. For the di.me userware, the concept should cover as well fine-grained sets of persons, e.g. the attendees of a meeting, groups like "friends", but also high-level concepts like "private lifesphere".

These objects form not only the system's information structure but also organize the access rights management: Databoxes, data, and profile cards can be configured to be shared with groups or individual persons.

Test results. As expected, these terms were self-explaining to the users. When asked how they would organize personal groups, few test participants suggested hierarchical groups for higher level groups like "business". The statement of most participants, however, was that they would use only few groups like "friends", "colleagues" etc. Only in some cases would assign people to multiple groups.

The service-provided groups (shown by a group of Facebook-friends in the test scenarios) were not expected together with the other groups by half of the participants.

These service-provided groups should be clearly identifiable as such and also be accessible via a list of connected services.

3.2   View Structure and Navigation Concept

The view structure has to visualize the UI objects and their relations in a flexible navigation. For that, the design approach of an object-oriented UI structure was adopted: Navigation and views are designed along the data UI objects, the relations amongst them, their attributes etc.

As *navigation concept for main views,* a typical tabbed view was chosen for the web UI (figure 1). The tabs form the main navigation for the main views and are offered at the top of the di.me use interface as a fixed header.

A first main view "People" (selected in figure 1) combines lists for the objects people and groups. Similarly, the data objects and the databoxes are shown in the combined view "My Data". This view type shows the full list of all elements on the top, and the expandable list of categories (groups or databoxes) in the bottom. The layout allows for a drag-and-drop interaction for assigning elements to categories. A second view type shows flat lists of elements, e.g. as thumbnails. This type is used for the main view "My Profile", which displays the different profile cards. Further main views were offered for messaging, system settings, or—only in some of the tested concepts—specific visualizations (a timeline, a configurable dashboard).

One central UI element that is being shown in the main views is the *properties bar* (figure 1, right margin column). It shows attributes of the currently selected object, general information (e.g. file name, file size, file path), but also the di.me access rights, related to the awareness of shared information (e.g. a list of files or databoxes that a person has access to). In addition, the properties bar can contain shortcuts to certain actions related to the object at hand.

For details of an element, different *sub-pages for object details* were developed. In addition to the page-oriented views, *modal dialogues* are used for actions like assigning items (e.g. data) to a category-object (e.g. databox), or sharing information to a person or a group via a particular identity (see section 4.3).

Test results. Within the first versions of the concept, two views for the *data and databoxes* were offered, whereby the view type for 'data" was focused on flexible searching and filtering, and the view "databoxes" on configuration of access rights. This separation, however, was criticized by the majority of the test participants. In fact, many participants spontaneously recognized the similar relation of people to groups and data to databoxes. Therefore they suggested similar layouts for both views.

Some insights were also gathered on the *priority of views*: The test particapants regarded the connection to different external services as one major functionality because this supports an easy overview of contacts and data in different systems and storages. For that, for users experienced with multiple communities the most important view was the list of people and groups, together with a direct visualization who is known via which service.

The *properties bar* (figure 1, right column) as common element for the main views was introduced based on the first usability test. Test participants strongly demanded a stable place for information about which information is accessed by a person, who has access to what personal information item by which service. Again, in particular power users working with multiple systems stressed this advantage. Also the requirement of getting a quick overview on people or groups can be realized if the properties bar shows aggregated information on multiple selected persons, groups, or data items.
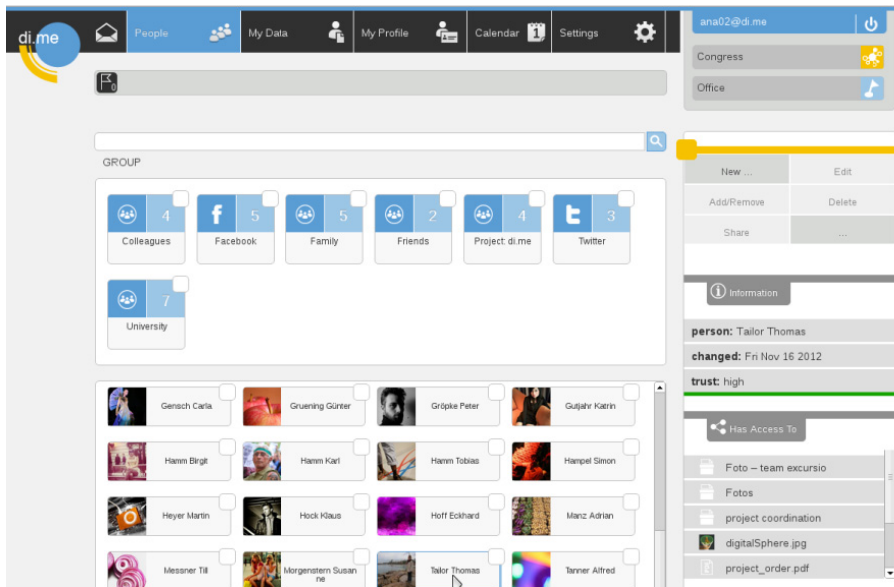

Fig. 1. Web UI: technical prototype with optimizations after the usability tests

3.3 Sharing via Multiple Identities

When shaping the presentation and interaction with identities in the di.me userware, the design decision was taken to offer *only* the profile cards for selecting the partial identity if it is needed for communicating or sharing with others. This implies that the non-global identifier, the service-account, is linked to the profile card: Selecting a profile card implicitly selects the service-account. As a result, the selection of a profile card decides on linkability and unlinkability: All information sent via a profile card is linkable to this identity. Other options were considered, e.g. to bind the service-account to a group. However, this would require the user to select service-accounts for groups, to define groups by considering identities and linkability for them, and to manage sharing rights for profile cards in addition. With the chosen concept, the service-account is not explicitly shown in the UI and the user only has to work with profile cards.

The selection of a profile card is shown in sharing dialogues (see figure 2a for the mobile client version): To share e.g. a photo, the user chooses an action "Share to ...". In an opened dialogue, the recipients and profile card to share 'via' can be selected.
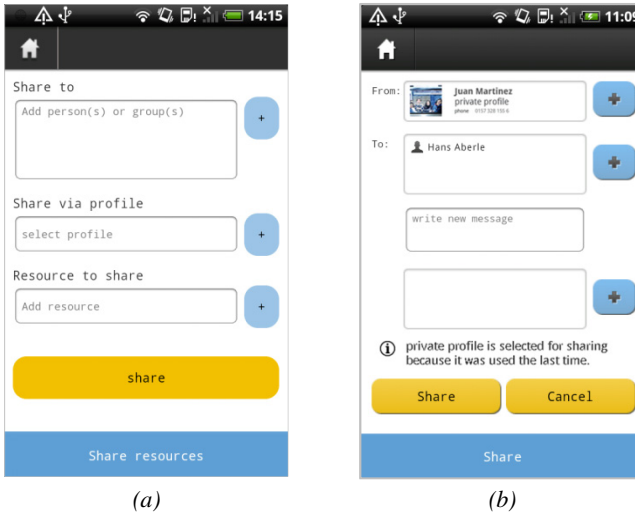

(a)   *(b)*

Fig. 2. Dialogues for the mobile UI: (a) "share resource" in the tested functional UI, (b) "Share" in a scribble with optimizations from the second usability test

Test results. In the second usability test, this interaction sequence and the underlying considerations were tested and discussed in detail with the participants. The general metaphor to change the identity used for a communication action by selecting the profile card was easily understood and not questioned by the participants. Having tried out the interaction flow, the participants took for granted that shared information would be linkable to the profile and to other information shared via the same profile.

Few participants mentioned that the content of a selected profile card must easily be checked so that the user can be sure what is being shared. In a wireframe done after the test (figure 2b) a preview of the profile card's information is added for that.

While the role of the service-accounts as non-global identifiers could not be deeply discussed with most participants, the participants assumed that the recipient cannot link this communication to other identities.

A further aspect was partly difficult to understand: The majority of participants suspected that a message was sent to Facebook if a profile card was selected that is synchronized with a Facebook-Profile. In the interview, the participants explained that the wording "via" (see figure 2, a) suggested this. Even if such a functionality is planned, the wording should point more to the fact that a sender-identity is selected. So, this could be changed to a label "From" as used for email-accounts (scribble in figure 2 b). As soon the function of pushing content via third services will be in place, this may additionally be indicated in the UI.

4   Summary

As an important result of the user-centered design, the information and UI structure was developed which represents the system domains of personal information, identities, and social sphere. After the user testing, the key UI concepts and view structure can be considered as stable.

However, further investigations addressing the interplay of the information structure and access rights are necessary: Specific cases like adding a person to a group will potentially change access rights (e.g. if the group has access rights the person did not own so far). For such cases, the awareness of the user must be ensured which requires additional information in the UI. An approach here is developed by the management of contact's trust in the di.me network (Heupel et al., in press).

The results of the user studies point into the direction that the profile cards connected to service-accounts as communication identifiers worked well with respect to the understanding of unlinkable identities. However, some implications of this design approach were not deeply investigated so far. E.g., if information is shared to a group, different profile cards may be known to its members. If a single card is chosen for sharing, it would be newly disclosed to a part of the group members. In this case, a *linkability warning* could be presented. A further requirement not investigated in the studies is the case of *intended linkability:* The user may want to inform a recipient that two profile cards are coming from the same sender. While users always may inform the recipient 'manually', the system should also support linking two profile cards.

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