

Oh, no! Not Another Web-based Desktop!

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Abstract—Among the advantages of cloud services, the most important are ubiquitous availability and collaboration support. Are the current technological solutions up to the job, in order to face the challenges posed by these two features? To provide an answer, the paper surveys some examples of online collaboration applications and concludes that what is still missing is an environment that acts as a “glue” with respect to all user online activities. We present *TablesPlusPlus* (T++), an online meta-environment handling thematic and collaborative contexts as *tables*. The user sits at to organize and perform her activities, thanks to an effective support to user collaboration. The paper discusses the characteristics of T++ and describes its architecture, together with our proof-of-concept prototype. T++ represents the missing environment, acting as a “glue” with respect to heterogeneous collaborative user activities.

Keywords—Online collaboration; cloud services; ubiquitous services; activity context; Web desktop.

I. INTRODUCTION

Cloud computing [10] is the paradigm that enabled the most recent step of a trend started with the so called Web 2.0 [37] some years ago: Web sites become more interactive, enabling users to perform various kind of activities online; tools installed on the user’s PC are replaced by services offered over the Net and accessed through a Web browser; connection availability increased significantly, enabling users to be almost always online; mobile apps available for smartphones and tablets enable users to connect to online services anytime/anywhere; social software provided over the Internet supports collaboration and sharing among users.

Cloud services (i.e., Web-based applications running “in the cloud”) have many advantages with respect to stand-alone applications: e.g., they are less expensive, they are always up to date, they are more secure. However, from our point of view, the two main advantages of cloud services are ubiquitous availability and collaboration support. A cloud service is always available to the user, provided that she has a device with a Web browser (or an app) and an internet connection. Moreover, cloud services provide a flexible and effective support to collaborative activities of users. Users can connect to their office applications from home in order to read or update documents; they can access their family calendar and schedule appointments while sitting on a train; they can participate in a discussion aimed at taking an urgent decision through their smartphones; and so on. Computer Supported Collaborative Work (CSCW) is a research field

that dates back to the ‘80s, but the growth of the Web in the last decades, coupled with widespread internet availability, has brought a huge impulse to the need of supporting user working or living in different places to collaborate on various kinds of activities, even outside the company environment. Moreover, a number of key factors have made Web-based user collaboration an issue of major importance. Such factors can be summarized as follows.

(1) In the last decade there has been a cultural shift towards “24/7 sharing” [20], meaning that people are, or need to be, always online, in order to share content, information, knowledge. In particular, Girard and colleagues claim that people born between 1980 and 2000 can be considered a “share generation”: they “grew up digital” and consider sharing information and knowledge as a natural attitude, much more than their parents [20].

(2) Many experts from different fields claim that encouraging collaboration in work environment results in huge benefits for the company itself. Effective collaboration and knowledge sharing among workers could result in an enhanced innovation capacity, decreased time to market, reduced time in the sales circle or in customer care services, reduced travel costs, easier decision making [20].

(3) Private and, in particular, family life has become much more complex than before [33][34]: families have to coordinate many mundane activities, involving parents, children, or both. School activities can require parents participation; children are involved in cultural or sports after-school activities; they have an active social life which has to be supported; parents have to merge work commitments with family needs and personal leisure; and so on.

(4) Work tends to be performed ubiquitously: it is not necessary, or possible, to be always physically at the workplace; people are more and more used to perform work tasks remotely, not only from home, but while traveling, for instance [28]. This trend leads to the idea of a *virtual enterprise* [20][33], in which physical offices are not important, or even do not exist, while many activities and communications take place in the cloud.

(5) Work and private life tend to mix together [20][33]: they are not distinct spheres any more, handled at different times and places, and with different tools. People get used to connect to their cloud office while at home, or on holiday; private and work calendars should be integrated in order to have an holistic view of personal schedules, which enables an integrated management of life activities [27][34].

The question this paper tries to answer is the following: are the current technological solutions up to the job, in order to face these challenges? To answer this question we will briefly survey the various available solutions supporting user collaboration in different contexts (Section II). On the basis of this critical analysis, we will conclude that what is missing is not just another collaborative tool, but a framework supporting the user in easily managing different collaborative tools all together. This goal is reached by proposing an innovative interaction model, implemented by an application that acts as a “glue” with respect to all user activities (Section III). We will conclude the paper highlighting the major open issues of our work (Section IV).

II. RELATED WORK AND MOTIVATIONS

An exhaustive survey of the existing Web-based applications supporting various type of collaboration is impossible to realize, since their number is huge. The AppAppeal Web site [4] provides a thorough review of more than two thousands existing online collaboration tools (grouped in 154 categories). However, we would like to take some of them into account, as representatives of the different categories, in order to provide an overview of the supported functionalities, which should highlight what is still missing. A good and wide survey can be found in [33].

The oldest and most popular applications that, to some extent, support user collaboration are online communication tools, like email, instant messages, and chat managers (e.g., AOL Instant Messenger [3], Windows Live Messenger [31]). More complex multi-party communication applications are Web-based audio/video conferencing tools, usually including file sharing, annotation, whiteboard features, chat, etc. An example is Skype [39], among many others. Moreover, online file sharing repositories (e.g., Dropbox [13]) enable users to store and to exchange files in different formats. Besides these “historical” solutions, there are plenty of applications enabling collaboration on specific activities. A significant example are online services enabling collaborative word processing, including spreadsheets and presentations editing (e.g., Google Documents [24], eXpresso [16], Empressr [15]).

The major family of applications supporting user collaboration includes groupware and project management tools. Many of the current solutions are Web-based (e.g., EGroupware [14], Feng Office [19], ActiveCollab [1], BSCW [7]), usually support workflow management, and are often integrated with communication tools, productivity applications (e.g., word processing), and document sharing.

Some recent online services provide a more flexible collaboration support. For instance, Cohuman (recently rebranded as Mindjet Connect Action) [9] supports users in coordinating and planning their daily tasks and projects; Kohive [30] is an Web-based collaborative desktop particularly suitable for small businesses and informal groups; Teambox [40] is an open source collaboration tool enabling users to coordinate team members by assigning tasks, managing projects, and sharing ideas and documents.

Moreover, there are many tool suites aiming at supporting collaborative work within the enterprise, like,

e.g., Microsoft Office 365 [32] and Google Apps for Business [23]. Such suites typically support email, messaging services, chat, and video-conferencing; collaborative word processing; file sharing, shared calendars, and often also Web site development and maintenance. Other type of enterprise cloud collaboration environments are tools like Cisco Collaboration Cloud [8], addressing teleconferencing environments to help small companies to be present at their customer sites, without traveling burdens.

All these applications are usually oriented to workflow and enterprise content management, and can be hardly exploited to manage the different aspects of everyday activities, merging business and private concerns (as outlined in Section I). Moreover, they are typically based on closed architectures: although they offer many services, the user is forced to abandon her favorite collaborative tools in favor of an exclusive adoption of the groupware application; another consequence of the closed architecture is the impossibility of plugging in external services, to enhance the system functionality answering a user need.

Besides enterprise-oriented applications, there are tools which aim at a simpler handling of to-do lists, thus more suited to informal collaboration contexts. E.g., Google Tasks [24] handles simple tasks as lists of text notes and it is integrated with Google Calendar [24] and Google Mail [24], thus enabling users to easily convert an email message into a task. Other popular task managers are Things [41], for Mac and iPhone, and DoIt [12]. These tools have some strong limitations: their integration with other possible sources of tasks (e.g., instant messages, social networks) is very limited; tasks are handled as simple text notes, with no structure and no integration with other applications supporting their execution; and their collaborative features are very poor.

There are also some environments aiming at providing comprehensive suites including different integrated collaborative tools. A popular example is Zoho suite [42], that includes online business intelligence and CRM tools, besides project management, collaborative word-processing, communication facilities, and so on. Another type of Web application geared towards providing a unified access to different collaborative tools are the so-called *Web-based desktops* (*Webtops*), usually characterized by a desktop-like graphical user interface, often similar to that of Windows or Mac OS, accessible via a simple Web browser. Some popular Webtops are eyeOS [17], Nivio [35].

All these solutions, providing a unified environment for accessing different services, are probably the best answer to the requirements stated in Section I. However, they still suffer a lack of integration with heterogeneous applications, since the applications available in such suites are only those provided by the same provider or by a partner of it.

Finally, there is a particular type of Web sites that, to some extent, enables user collaboration, and that is worth mentioning since it is by far the most popular way people use to communicate and share contents: social networks, like Delicious [11], enabling users to keep their bookmarks online and to share them, or like the more generic Facebook [18] and Google+ [26]. Within social networks, the main goals are communicating and sharing rather than

collaborating. Miller states this very clearly: “I find social network groups especially useful for community groups, far-flung friends, and families. You get just enough functionality to keep everyone in touch with each other” [33]. “These groups lack the advanced collaboration features that help to keep group projects on track” [33]. However, since they are used by a huge number of people, we think that they must be taken into careful account. Thus, in the following we briefly survey the main functionality of the most popular one, i.e., Facebook, and of its most recent competitor, Google+.

Being both social platforms, Facebook and Google+ share many features. In both cases, the main interaction metaphor is accessing a “stream” of content, and the basic activities are reading/publishing posts and state updates, and sharing information. Both Facebook and Google+ enable the user to create private, possibly overlapping groups of contacts, which in Google+ are called *circles*. The main goal of Google+ circles is *selective sharing* (users can publish content available only to some circles) and *selective following* (they can decide to see only the contents published by members of a circle). Chat presence is not selective with respect to circles/groups; however, in both Facebook and Google+, the user can manually configure selective presence with respect to pre-defined lists of contacts. Group chat can be used to plan activities with multiple people, in both cases. Google+ is fully integrated with many Google services (e.g., Google Mail, Google Documents, Google Talk); similar services are provided also by Facebook, but Google services integration is supported by the Google toolbar, which provides notifications concerning the Google environment even when the user is not looking at any Google+ page. Finally, both platforms are easily accessible from mobile devices (through Android and iPhone apps).

Besides these common features, there are also some differences. The first set of differences concerns Google+ circle management (with respect to Facebook groups). Circle names (and thus circles *tout court*) are visible only to their owner, and represent an individual “perspective” on the social network. On the contrary, Facebook groups are “in the world” and are not simply a “view” of it. When invited, a user receives a notification and is automatically added to the group. The mechanism is similar in Google+: circles can contain people I think are interesting, even if they are not aware of belonging to a circle of mine, and even if we do not know each other; Google+ notifies you if I added you to one of my circles, but does not notify if I move someone, for example, from my “friends” circle to my “ugly people” one. One of the most interesting aspects of Google+ is that users can share a post with people who are not Google+ users: in this case, sharing is done via email. Finally, Google+ offers an innovative functionality, called *hangouts*: Google+ users can access virtual video-rooms where people can meet online to chat or to see a YouTube video all together. An interesting aspect of hangouts is that they do not have an “owner” and control is totally “egalitarian”: everyone in it can invite anybody else and can act (play, stop, pause) on a YouTube video shown in the “room”.

We would like to conclude this section by highlighting the main reasons why social networks are not enough to

support user collaboration in the perspective outlined in Section I. As we stated above, social networks are mainly focused on communication and sharing, enabling the user to move within structured streams of contents. As a consequence, in Facebook groups, collaboration tools are basically limited to chat interaction; in addition, Facebook chat, like other chats, is limited from a workspace awareness viewpoint, since it does not support selective presence based on group membership. Also Google+ circles fail to support user collaboration in a general sense: each circle, in fact, exists only from the viewpoint of its creator, and thus it cannot be used by the circle members for managing the execution of shared activities. Moreover, due to their different goal, social networks, similarly to the other collaborative environments discussed before, lack the integration with heterogeneous services. Thus, social networks, like many other collaboration tools mentioned above, can be seen as one of the possibilities offered to Web users to communicate, share and - to some extent - collaborate online. However, what is still missing is a meta-environment which should be able to manage all the different tools the user is used to, by organizing them in workspaces which have, as their main characteristic, the effective support to a “egalitarian” and user-friendly collaboration. Next section describes our proposal in this direction.

III. OUR PROPOSAL: TABLESPUSPLUS

The interaction model we propose is based on the metaphor of *tables* the user sits at in order to perform (online) activities. Tables represent activity contexts, and can be created around an interest or a more specific goal. E.g., we can have a permanent table about my interest in Buddhism, but also a temporary table for the organization of a journey to India. The meta-environment enabling users to create and manage tables is called *TablesPlusPlus* (T++). In the following, we will describe a usage scenario, to provide the reader with an intuitive idea of the support that T++ could offer. Then, we will characterize tables in order to differentiate them from currently available proposals, and finally we will present T++ architecture, together with our proof-of-concept implementation.

A. Usage Scenario

Maria is a 40 years old researcher at the local university; she is married with Marc and they have two children, Albert and Paula; Maria is interested in Buddhism, and sometimes she leads travel groups to India. Within her T++ environment, she has (among others) the following tables:

(T1) *Research*, used to manage her collaborations with her research group at the university. Table members are four colleagues of her. Objects lying on this table are: a Zoho Project, used to manage a research project including foreign partners; various documents concerning her current main research thread; some related papers and materials (links to online pdf documents or Web sites); a small workflow, used to handle tasks concerning a national project proposal.

(T2) *Family*, used to manage family life. Table members are her husband Marc, her children, and her mother Louise. Objects lying on this table are some to-do items (e.g., book a

visit to the dentist for Albert), a shared document containing the shopping list, a link to the Genova Aquarium Web site (Paula is going there with her classmates next week). This table is also subscribed to a public publish&subscribe (P&S) service, where children's school office publishes news about interesting events involving families.

(T3) *Buddhism*, used to handle the activities related to her interests in that topic. Table members are Daniel and some other friends. Objects lying on this table are links to articles, books and Web sites concerning Eastern philosophy. This table is also subscribed to a public P&S service, where some associations related to Buddhism publish news.

(T4) *Journey to India*, used to organize the journey she will lead, planned for next summer. Table members are Linda (the secretary of the tour operator organizing the journey) and Daniel (who usually helps her in arranging the cultural aspects of her journeys). Objects lying on this table are links to Web sites related to travel locations and a to-do list with activities concerning the travel organization.

All Maria's tables contain her calendar, shared with the other table members. Visibility can be configured with respect to single tables (e.g., when sitting at the *Research* table, people see that Maria is not available next Friday, but they cannot see that she will be in Genova with Paula).

At lunch time, Maria is in her office; she sits at the *Family* table and notices that both her husband and grandma' Louise are at the table too; so she writes a message on the table blackboard to decide who is going to take Albert to the basket training session and Paula to the jazz-dance class. Louise reads Maria's message and offers to take Paula; Marc asks Maria to contact him later on in order to decide who will take Albert. Maria, by a simple click, transforms Marc's message in a task *Contact_Marc* with deadline at 17 (automatically copied also as a calendar event), and creates a new task, *Take_Paula*, assigned to Louise.

While Maria is at a café for lunch, she receives an alert on his smarthphone, notifying her that the *Buddhism* table has been updated. Maria enters T++, sits at the *Buddhism* table and read the new message about a conference on Buddhism in Western countries, arrived from the P&S service. She decides that the conference is interesting, thus, by a simple click, she adds it to her calendar.

Later on, when she is back home, she connects again to T++ through her personal tablet, sits at the *Journey to India* table and starts writing a document (using Google Documents) describing the cultural events for the journey. Daniel appears online and comments on the content that Maria is writing. The collaborative editing goes on for a while; Daniel and Maria also add some references to interesting Web sites they found, as new table objects. When they leave the table, Linda is notified about table updates.

B. The Role of Tables

Within T++, tables have been conceived in order to support and facilitate "democratic" and user-friendly online collaboration, by providing, at the same time, a flexible and manageable integrated organization of individual activities: this is the most important aspect underlying T++ design. Moreover, the following features are important in order to

understand the role of tables and to differentiate them from simple user groups.

(1) Tables in T++ are meta-structures upon applications and services. The goal is to build a "view" on the user own Web space, used to collaborate and to organize her activities, hopefully not providing yet another tool. In particular, tables represent *thematic contexts*, helping the user to manage separated, coherent and structured workspaces, encompassing all types of activities (from personal to work-related ones). At the same time, tables represent *common places* where users can, synchronously or asynchronously, share information, actively work together on a document, a to-do list, a set of bookmarks, and so on.

(2) Tables are populated by *objects*, rather than links to applications and services. Such objects can be of any sort: documents, to-do lists and workflows, calendar views, bookmarks, images, Dropbox "spaces", projects, and so on. Moreover, they can be labeled as "public" (i.e., visible to all table members) or "private" (i.e., visible only to their creator). Also table messages can be public, i.e., published on the table blackboard and thus visible to all table members, or private, in which case they represent personal notes.

(3) Objects can be tagged, in order to structure them in (possibly multiple) categories, easily accessible through a tag cloud. For example, on the *Journey to India* table, Maria could tag a set of objects as "travel organization", and another (possibly overlapping) set as "cultural evenings".

(4) Tables enable users to collaborate with people sitting at the same table: every table participant is enabled to modify public objects lying on the table. This means that every table participant can, for instance, edit documents lying on the table by accessing an online word processing service, but also that she can organize the table, by adding and deleting objects, as well as by inviting people. Differently from all types of "virtual rooms", tables enable both synchronous and asynchronous collaboration. In fact, they notify table members - according to the notification policy individually configured by each member - about all relevant events occurring on the table (e.g., an object has been added or modified; a new public message has been published on the table blackboard; a new member has joined the table; a task has been completed; and so on).

(5) Tables are shared: they are not a single user's "view" on objects and people, but a "collective view": when a user sets up a table and invites people, everyone who agrees will see the table and will be able to work on it. For this reason, users invited to a table become members of it only if they agree (differently, for example, from Google+ circles).

(6) Tables represents activity contexts enabling workspace awareness and selective presence: differently from standard chat tools, when a user is sitting at a table, the (default) presence panel will show her a list including only table members, and, among them, who is currently online and sitting at that table. When a user is sitting at a table, she remains invisible within other tables, thus she is not disturbed with chat or calls coming from different contexts.

(7) Tables contain members' calendars, shared with the other table members. However, the visibility policy can be configured with respect to single tables: for example, the

user can decide to completely hide her calendar on table T1, to allow complete visibility (e.g., what she is doing during the weekend) on table T2, and to enable partial visibility (e.g. only that she is busy during the weekend) on table T3.

(8) Scheduling of common activities is supported by the *Smart Shared Calendar Management Service*. This service is briefly described in Section III.C (see also [5]).

(9) Tasks, to-do lists, and lightweight workflows are managed by the *Collaborative Task Management Service*, which is briefly described in Section III.C (see also [5][6]).

(9) Other objects are managed by the user's favorite collaborative applications. When double-clicking an object, or choosing the "modify" option from the object menu, the corresponding application is run, enabling the user to view/modify the object.

(10) A person can be member of different tables and an object can belong to different tables (in case of editable objects, like Google Documents items, if the user tries to put on a table T2 an object that already lies on table T1, the system asks her whether she wants to add it in read-only modality or if she wants to create a new independent copy).

There are two further characteristics that are particularly meaningful in T++, since they represent the openness of the environment, by enabling users to link tables to remote services, and allowing the participation of people which are not fully T++ registered users:

(11) Tables can be subscribed to public P&S services, where external services publishes news (e.g., RSS feeds); subscribed tables receive messages from such hubs and publish them on the table blackboard, thus making them visible to all table members (see Section III.C).

(12) People can collaborate to a table work even without being users of the T++ environment. An example scenario of how T++ manages the interaction with people who are not T++ users is the following. Maria would like to invite her friend Ann at the *Journey to India* table, even though she knows that Ann does not want to register to T++. Maria, through the table user interface, sends the invitation (an email with an "accept" link). If Ann accepts the invitation but does not register to T++, she will simply receive an email confirming her membership to the table (and the system keeps track of her through her email address, as a *non_T++_user*). If Maria publishes a public message on the table blackboard, T++ sends Ann an email containing Maria's message. Ann can reply to this email: T++ receives her answer and publishes it on the table blackboard (making it thus available to all table users). The same mechanism enables Ann to receive notifications coming from P&S services the table is subscribed to (see Section III.C).

Finally, it is worth mentioning that T++ is accessible both from desktop PC and from mobile devices (including smartphones); see Section III.C for some details.

C. T++ Architecture and Proof-of-Concept Prototype

The T++ environment is implemented as a cloud application. The proof-of-concept prototype is a GWT [25] application, deployed on the Google App Engine [22], but the same architecture should work on other cloud hosting environments. The cloud services offered by T++ are

available both from the GWT client running within the browser and from the Android App, as shown in Fig. 1. We exploit the Android Cloud to Device Messaging (C2DM [2]) to send data (lightweight messages) from servers to the applications on Android devices.

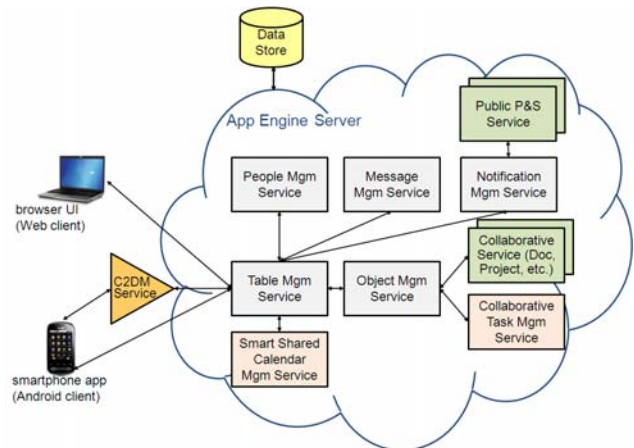


Figure 1. T++ architecture.

Fig. 1 also depicts T++ architecture. The main component is the *Table Management Service*, that handles tables within the environment. The *Table Mgm Service* exploits the *Smart Shared Calendar Management Service*, that automatically accesses members calendars to find time slots in which they are available (see [5]). The *Object Management Service* handles all the issues related to objects lying on tables. It exploits other collaborative applications in order to offer tools for collaboratively modifying objects: e.g., a collaborative online word processing application (like Google Documents), a project management tool (like Zoho Projects), a social network (like Facebook), and so on. Moreover, it exploits the *Collaborative Task Management Service* (see [5][6]), that enables table members to share tasks, to partially order them in lightweight workflows, and to link each task to the Web tool needed to perform it. The *People Management Service* handles table membership and selective presence. The *Message Management Service* handles user public messages, published on table blackboards, and user private notes. The *Notification Management Service* takes care of the notifications related to table activities. Notifications can be generated by table events (table members performing some significant action on the table), or by external public hubs (*Public P&S Services* in the figure) tables are subscribed to.

T++ exploits the JavaMail API [29] and a T++ email account (on Google Mail) to send and receive messages from people who are not T++ users. The T++ users already registered as Google or Facebook users do not need to register again, given that the *People Mgm Service* exploits OAuth [36] to give access to users and collect information already available on their Google or Facebook accounts.

All T++ cloud services exploit the App Engine schemaless Object Datastore [21]: they save data objects as entities having properties, i.e., named values of one of

several supported data types. The datastore can execute multiple operations in a single transaction: this is especially useful for distributed Web applications like T++, where multiple users may be accessing or manipulating the same data at the same time.

The subscription of a table to a public P&S service (e.g., Pubsubhubbub [38]) is a simple operation, consisting in adding an URL in the table configuration panel, and is one of the operations available to table members, when sitting at the table. Moreover, tables can be configured in order to react to published events in a more complex way. This kind of integration requires the implementation of some code within the Table Mgm Service. The complexity of such code depends on the format of the data published and on the nature of the internal activity to be triggered (see [5] for more details about remote services integration).

IV. CONCLUSION AND FUTURE WORK

In this paper, after an analysis of some examples of different types of Web-based collaborative tools, we concluded that what is missing is a framework providing the user with a “view” on her own Web space, effectively supporting her in collaborating and organizing her life activities. We thus proposed T++, a meta-environment based on the metaphor of tables, i.e., activity contexts that can be created to handle objects (documents, links, tasks, and so on) related to an interest or a specific goal. In presenting T++, we also took into account the possibility of subscribing tables to public P&S services, in order to get information from remote services, and the possibility, for people who are not T++ users, of collaborating to a table work through their email accounts. These two aspects, in particular, require further work. The integration of T++ with remote services through public P&S services could be enhanced taking into account the semantics of the exchanged data. The interaction with not T++ users, could be enhanced by supporting, within a table context, the usage of other online collaborative applications the user may be registered to (e.g., Facebook).

The need for an effective support to a “democratic” and user-friendly online collaboration coupled with a flexible and integrated organization of individual activities has been elicited by means of informal interviews with Web users used to exploit social networks and online collaborative tools. However, the actual usefulness and usability of a framework like T++ depends on the evaluation of real users; for this reason, we are planning a set of tests with Web users, aimed at evaluating these aspects of our proposal.

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