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Generating Awareness from Collaborative Working Environment using Social Data

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***Abstract*: Nowadays, Internet is a place where social networks have reached an important impact in collaboration among people over the world in different ways. This article proposes a new paradigm for building CSCW business tools following the novel ideas provided by the social web to collaborate and generate awareness. An implementation of these concepts is described, including the components we provide to collaborate in workspaces, (such as videoconference, chat, desktop sharing, forums or temporal events), and the way we generate awareness from these complex social data structures. Figures and validation results are also presented to stress that this architecture has been defined to support awareness generation via joining current and future social data from business and social networks worlds, based on the idea of using social data stored in the cloud.**

***Keywords*:** Awareness, Social data, Network Science, Collaboration patterns, CSCW, Web 2.0**.**

I. Introduction

In the last years, due to the Web 2.0 movement, the social web applications are one of the areas where new technologies are more important, not only to demonstrate the capacities of these new technologies, but also to socialize Internet. As a result of this evolution, different kinds of relevant social networks have appeared such as Twitter or Facebook. Users connect themselves with the entire world in the way they prefer, generating an incredible knowledge shared in the Internet and in some cases, accessible for everyone.

On the other hand, the business world have understood the advantages of this social way of collaboration, because one of the most important problems in today enterprises is keeping its employees "know how" in case they leave the company. Besides, revealing the collective activity and generating awareness from it, is also an essential concern that enterprises have. For this reason, the Computer Supported Cooperative Work (CSCW) tools have been significant for business world since they appeared in the 1980s [1]. These tools used to have a rigid structure completely different from the social web movement concepts. However, applications like Microsoft Office Communicator 2007 and IBM Lotus Connections are starting to evolve to more dynamic schemes.

In this article, we propose a new point of view of CSCW tools according to social web ideas, in order to offer the common aspects of these tools (collaboration among users), and the possibility of generating social awareness from the data structures in which is based our application, so users can study their own collaborative context and their ties with other users.

This new CSCW 2.0 that we have developed is named CollawareSoft. It has been deployed within a banking environment and during the last months it has been used to provide advanced collaboration in this business context.

The structure of the article is divided as follows: the next section gives a summary of the most important user requirements, and a common case of use starred by an imaginary worker called Bruce is presented. Section 3 describes the architecture and the main concepts of the implementation of this application. Section 4 aims to place the main ideas behind Social Awareness. Section 5 describes the way the social awareness is generated in CollawareSoft using the social data structures in which it is based on. Section 6 presents the results of evaluating the Bruce's awareness problem use case presented with real users. After that, in Section 7 we discuss the previous results. Finally, the last section provides some concluding remarks derived from this implementation and some lines for further work.

II. Functional and User Requirements

Before building CollawareSoft, we decided to analyze our users' requirements. Also, it was important to place the functional features that a CSCW system must include.

For this reason, we followed the taxonomy described by Reinhard et al. [2], so as to achieve a solution to the first problem (keeping the "know how" in the company and allowing collaboration among workers):

- *Interaction*: two kinds of interaction are possible in CSCW environments: synchronous (e.g. audio conference, videoconference, chat and desktop sharing) and asynchronous (e.g. forums and e-mail). As we said before, our idea is to follow the social web movement, so both types of interactions are available for users.
- *Coordination*: this property is based on the size of the users groups and the way they communicate among themselves. It depends on the social context they conform (e.g. conference, discussion forum, brainstorming sessions, etc). Therefore, it is necessary to establish different user roles such as administrator, reviewer, publisher or guest.
- *Distribution*: following the ideas placed by the social web involves having a distributed working environment. Thus, we chose Client-Server architecture with a web client which helps users to interact in a distributed way.
- *User-specific reactions*: the system must be collaborative aware, so it reacts depending on the individual roles of each user, offering a different user interface based on his permissions.
- *Visualization*: we have built a system that follows the Rich Internet Applications (RIAs) tendencies [3], where the Human-Computer Interaction (HCI) is near to desktop applications and the usability is higher than in traditional web pages.
- *Data hiding*: CollawareSoft separates public from private data using workspaces to identify different collaborative groups.

Arrived to this point, we can add a new important property focused on solving the second problem raised in the introduction:

- *Social awareness*: generating user context from social and temporal structures of collaboration helps people to understand the activities and projects around them. Besides, this awareness provides important information about the position of the user in the groups he collaborates. Hence, a good way to achieve this is by building contextualized awareness from CollawareSoft's social data.

Finally, to describe what we mean with the properties we have just set, we are going to see how our proposal can help to resolve a common problem in everyday collaboration: "*Bruce is a software designer who is starting to work in a new department of his company, in a project related to cloud computing topics. He does not know much about these concepts. As a consequence, he needs to talk with his new co-workers to bring up to date himself, but he does not know who the experts are. What can he do*?"

At the end of the article, we will see how our system resolves this current problem in today enterprises.

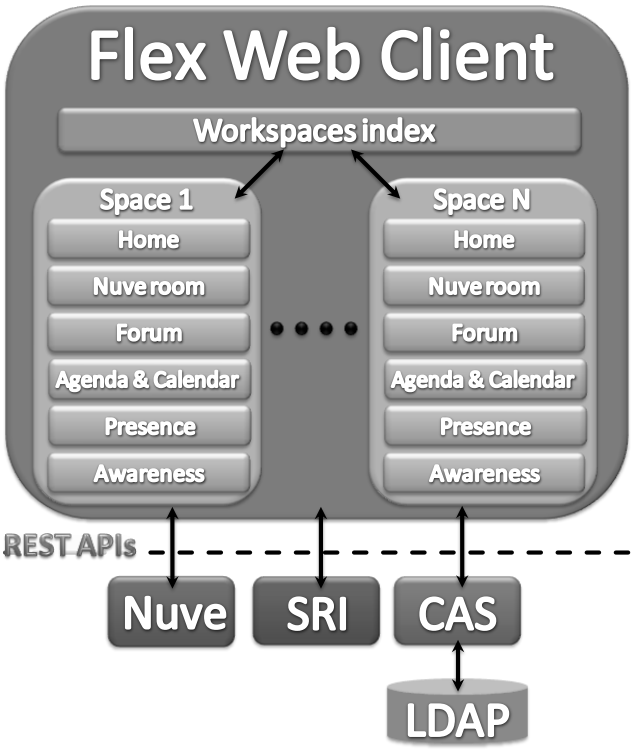

Figure 1. CollawareSoft architecture where the web client communicates with server modules through REST APIs.

III. Collaborative platform: CollawareSoft

In this section, we describe the general details of the implementation of the collaborative platform CollawareSoft, developed following the Scrum methodology [4]. Scrum is an agile process that can be used to manage and control complex software and product development using iterative and incremental practices.

The architecture chosen was Client-Server, in order to achieve the distribution property introduced previously.

The main components of this architecture are illustrated by Figure 1. We are going to explain each component in a little more detail.

A. Server

1) SRI: Social Resources Infrastructure

It is the infrastructure responsible for providing the social data and the collaborative structures needed to build the system. It acts as a gateway between the data base and the web client.

The SRI is a web application implemented in Ruby on Rails [5] following the Model View Controller [6] design pattern.

It also has an Atom REST API (as we can see in Figure 1) designed following the concepts put forward by Fielding [7]. It provides communication with the web client, so the client can manage these social data stored in the data base through the HTTP methods described in Table 1.

The REST resources offered by the SRI are:

- *Users*: all the application's users.
- *Spaces*: identify a group of users or a specific project.
- *Events*: allow to manage the agenda and calendar events.
- *Articles*: forum posts and comments allowing asynchronous interaction.

Table 1. Available methods in the SRI's Atom REST API.

HTTP Request	Atom Attached	URI	Rails methods	Atom Response
GET	No	/ resource.atom	Index	Yes
POST	Yes	/ resource.atom	Create	No
GET	No	/resource/id.atom	Show	Yes
PUT	Yes	/resource/id.atom	Update	No
DELETE	No	/resource/id.atom	Destroy	No

- *Performances*: specifies the different roles that a user has in the spaces he belongs to, providing coordination.

In addition, we must emphasize that the format chosen to communicate information between the SRI and the web client was Atom. This decision was based on the generalized used of this format in the Internet during the last years.

Specifically, the SRI uses standard Atom namespaces (some of the used by Google and Blogger). This allows CollawareSoft to connect with third-party social applications easily.

It is also important to say that two protocols are necessary to carry out the CRUD operations (Create, Read, Update and Destroy) in Atom. The Atom Syndication Format [8] to read the resources, and The Atom Publishing Protocol [9] to create, update and destroy them.

For this reason, taking into account the previous protocols and the methods illustrated in Table 1, we can analyze the Figure 2. It describes the general architecture and the processes involved in the communication between the web client and the SRI. As we can see, the SRI acts as a wrapper of the database where the information of the social resources is stored.

B. Nuve: Videoconference as a Service

As we can see in Figure 1, another module in the server side is Nuve [10]. It offers videoconference rooms as a service in a cloud computing way. It also offers access to a collaborative synchronous interaction environment including audio, video, chat and shared applications.

Nuve, developed by the authors' research group, is the evolution of Marte 3.0 [11], a videoconference Client-Server service. The Nuve architecture extends the past implementation to a scalable Cloud Computing service which provides virtual rooms to users based on the CollawareSoft demand.

Furthermore, when we create a new space, it has associated a Nuve room where the users of the space are registered. In consequence, we have a one by one relationship between SRI spaces and Nuve rooms.

C. Authentication: CAS and LDAP

The last components presented in the Figure 1 are the CAS and LDAP modules responsible for user authentication. The CAS module is used to provide a Single-Sing-On service to authenticate the web client in the SRI (and of course, any future module we want to add).

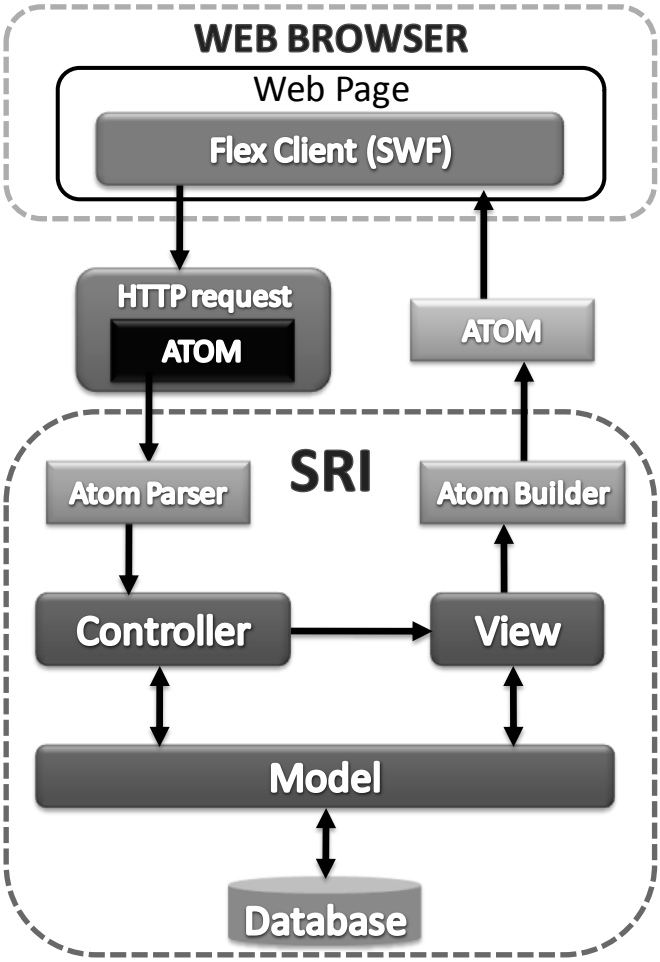

Figure 2. Communication architecture between the Flex client and the SRI server module through the Atom REST API.

The client communicates with this module through HTTP requests using the RESTful API [12]. Then, the CAS module interacts with an LDAP database that stores users' data and performances. Hence, the user credentials are validated after this process, generating the tickets necessary to start a SSO session.

D. Client

The CollawareSoft web client has been developed following a RIA paradigm, using Adobe Flex for its implementation. It covers the user-specific reactions and visualization requirements that we presented in section 2. This issue has an additional benefit: the user does not have to install anything in most cases because today browsers usually have the Flash Player plug-in installed. In particular, we use the open source framework Cairngorm [13] to design the application because it provides Model View Controller (MVC) architecture, suitable for a client-server application.

Consequently, the client is principally based on a collaborative structure where the space is the main unit in the application. In other words, users belong to one or more spaces where they collaborate among themselves using a set of collaborative tools created via the SRI's social data.

Thus, every space has the following tools available for all the users registered in any space (illustrated in Figure 1):

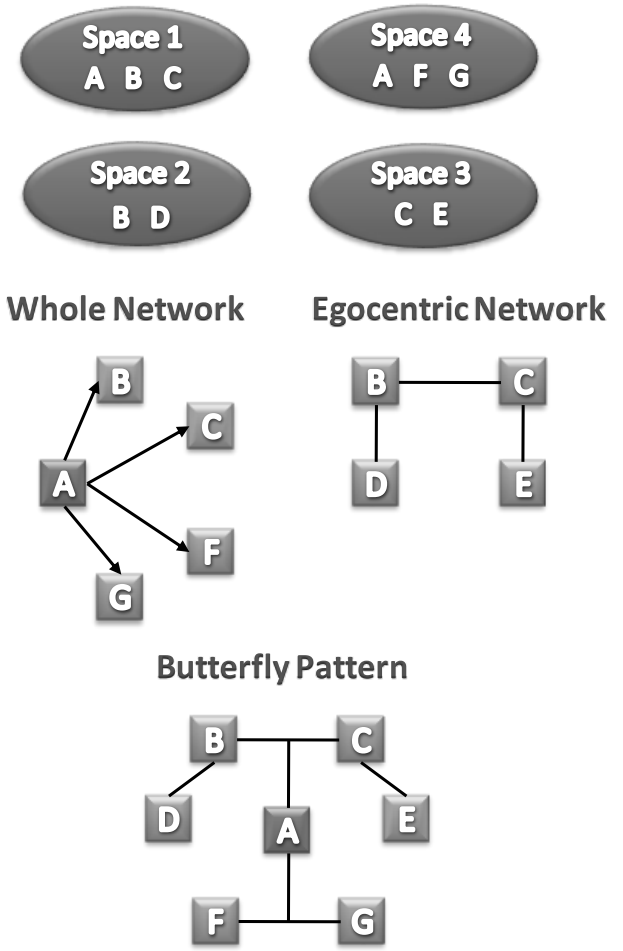

Figure 3. Generation of collaboration patterns using spaces and users resources.

- *Home*: informs about the next space events and the recent posts in the forum, helping the users to be aware of space's recent activity.
- *Nuve room*: provides a videoconference room with chat and desktop sharing, allowing a synchronous communication.
- *Forum*: this tool, based on the SRI's articles resource, offers the possibility of creating conversation threads to collaborate in an asynchronous way.
- *Agenda and Calendar*: it is based on the SRI's events resource. It allows organizing meetings and events related to the space activity.
- *Profile and Presence*: provides the users' public profile information in the space and a presence service to know who is on-line.
- *Social Awareness*: this tool is in charge of generating collaborative context for a user or a group of users in a space. Thus, they can be aware of the collaborative life and social ties that exists in the application.

Besides, due to the fact that we have a single client that integrates all the server modules, the orchestration among the services provided by them is accomplished. For this reason, it is possible to have for instance a videoconference session while we are reading the forum messages or using the social awareness tool.

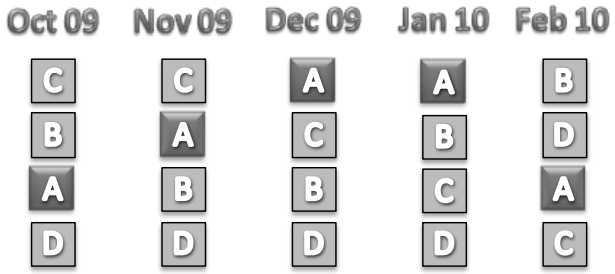

Figure 4. Generation of Top 4 pattern based on users and articles resources.

As a consequence, we can state that the design requirements proposed at the beginning of this article are accomplished by the system.

IV. What is Social Awareness?

During this article we have talked several times about social awareness, but we have not defined it yet. Here is a brief definition:

It is the capacity of perceiving and being aware of events, relationships or patterns, that allows us to understand the current context of one person or one group.

Yet, before talking about how it is generated in our system, we must first bear in mind the concepts behind the awareness generation. In our case, we follow the ideas described by Fisher and Dourish [14]:

- *Social Networks*: they are probably the most important part of the awareness generation. The Social Network analysis has been broadly studied in the social science area [15]. They describe the relationships that exist in sets of people by analyzing some social aspects or personal links among them. Also, using social networks we can find out social structures and working groups, understanding special roles of some of their members.
- *Temporal Structures*: they describe how the social networks evolve through time. Thus, they show the collaborative rhythms that a specific person experiments in the different groups or projects he belongs to.

As a consequence, the joint of these two concepts and their analysis generates the social awareness that we are looking for.

V. Generating awareness from CollawareSoft

Now that we have reached this point, the question is obvious: how do we generate collaborative context on CollawareSoft? We have a very wide and rich set of social data structures which can be used as an input to generate collaborative patterns, so we are going to raise the different options to generate this information using the resources provided by the SRI: users, spaces, articles and events.

First of all, we must take into account that a space is a collaborative structure itself. Thus, the first thing a user notices when he enters a space is the users registered in it. As a consequence, the generation of collaborative patterns based on the spaces and users resources is immediate. Figure 3 shows an easy example about how the system internally generates

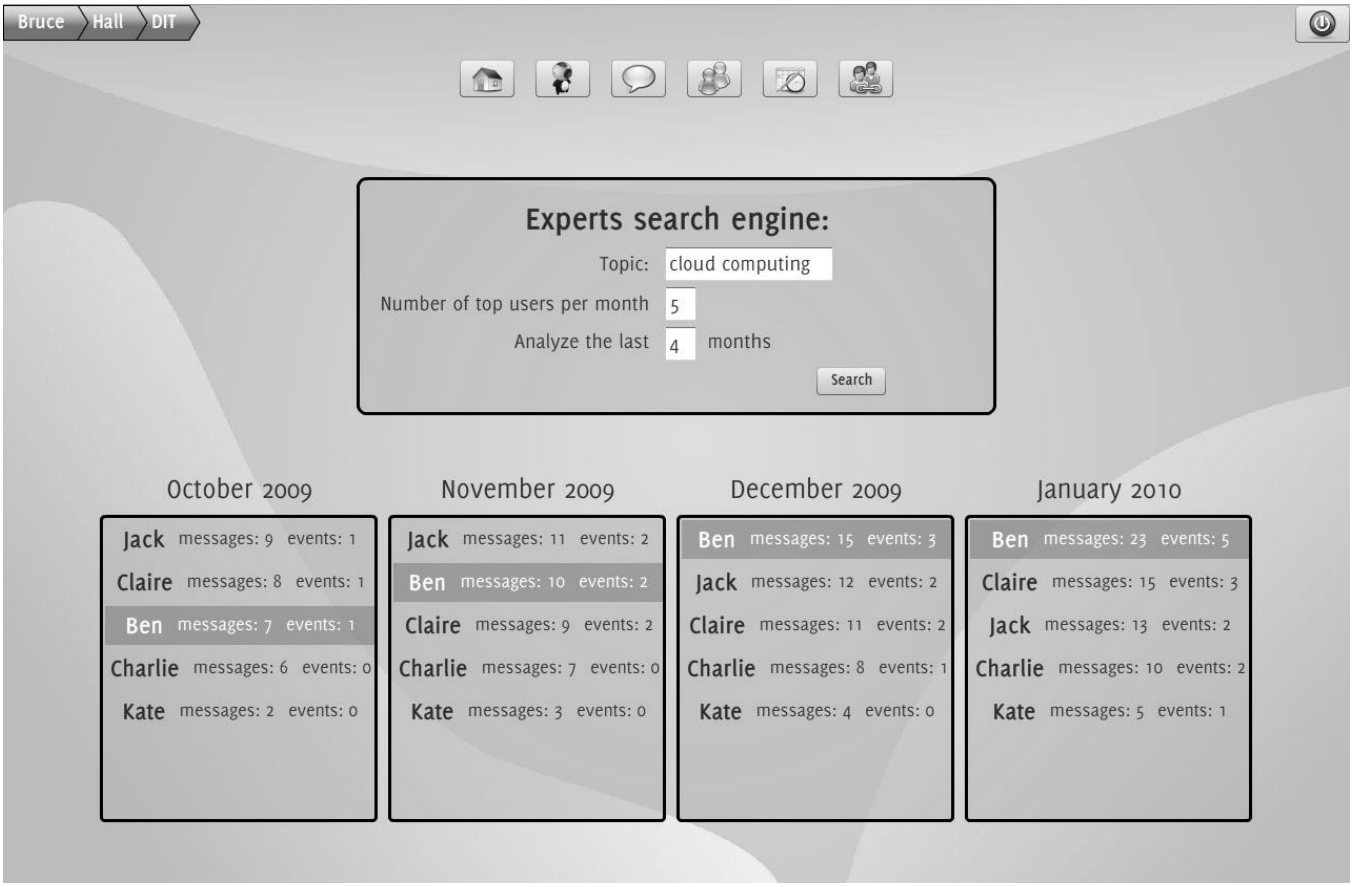

Figure 5. CollawareSoft screenshot of the social awareness generation tool.

awareness for the user A. As we can see, he belongs to two spaces (1 and 4) in which he collaborates with several users (B, C and F, G respectively).

Regarding the Whole Network pattern, we can obtain what his collaboration issues with these users are (i.e. social ties), by checking over the users that share spaces with him.

If we attend to the Egocentric Network [16] pattern, we get awareness information by relating different users to each other. According to the analysis of the users that share spaces with A, we can notice that the work teams formed by {B, D} and {C, E}, that seemed to be disjoint, are in fact linked due to the collaboration between A with B and C in space 1. Then, we can see in the scheme how the relation is so, because of these users. For this reason, although A does not collaborate with D and E at this moment in a direct way, he can notice their activities through his relationship with B and C, and in the future these ties could be useful for him, for example to look for experts, as we will see later.

Finally, the Butterfly pattern (also known as Dual Roles pattern) informs us that A is the union nexus between two different working groups. Thus, we can use this kind of patterns to identify the different A´s roles inside the company and locate him in its collaborative context in a more accurate way. For instance, A could be a project director with two workers (F and G) and also he could collaborate with other 2 project directors B and C that lead their own teams.

On the other hand, by analyzing forum conversation threads we can extract social information. Thus, we can connect users among themselves regarding the parent-child (post-comment) structure of these messages. Furthermore, we add time analysis to provide temporal structures to the social networks we have generated before. We can do this because all the posts and comments published have a date and an author that becomes into messages more or less significant. The result of analyzing articles and users resources is presented in the Figure 4. It presents a Top 4 pattern informing about the evolution of forum messages written by the user A in 5 months compared to the users that share space with him or her.

Another way of generating awareness is by using the joint of events and users resources from the Agenda and Calendar component, attending to the topics and users groups that created these events in the space. We will see a real example of this in the next section.

Finally, there is another way of analyzing in a higher level these social data. If we take into account that usually, the collaborative patterns do not appear isolated and they sometimes overlap, we can combine them to generate Macro Patterns.

This kind on new patterns give us a more complete and truthful information about the awareness of a user or a group than simple patterns. For example, the Butterfly pattern illustrated in figure 2 has implicit inside it the Egocentric Network pattern. Therefore, this new macro pattern shows us more information about the awareness of the user A. Consequently, when we want to generate awareness, we can analyze our social data in several levels depending on the

detail and user interrelationship level that we are looking for.

VI. Evaluation and Results

As we have said in the Introduction, CollawareSoft was deployed in a Spanish business environment to be tested by real users belonging to our partner in this research.

After its deployment, a light evaluation was carried out to validate this tool using a similar method to the one used by Gutwin et al. [17]. For this reason, one of the main objectives of this evaluation was to discover the benefits achieved and the possible lacks of using this system in this real context.

The selected approach for this study was based on an online survey to collect subjective measures of the user experience given by 30 users. Therefore, we let them to use CollawareSoft during one month, and then they score the system in relation to a set of properties. Bearing in mind that was too difficult to achieve the same scenario of using the application for all of them, we presented in the survey the Bruce's case we have described in this article.

A. Scenario

We supposed that the company where Bruce is working has deployed CollawareSoft several months ago to provide collaboration among their workers. In that case, "*Bruce uses the Experts search engine present in the application to look for cloud computing experts in his new working project which has a space (named DIT) in the application. Thus, he selects cloud computing as key words for the topic input; 5 top users to be shown per month in the results and a period of time to be analyzed consisting of the last 4 months*".

The Figure 5 illustrates that the result is a Top 5 macro pattern that shows the cloud computing experts in the space during the last four months. Our awareness generation tool has internally analyzed the temporal evolution of the users that have written messages in the forum or has organized events about this topic. By a data mining process, then it has ordered them attending to its importance, taking into account the social ties among themselves, using collaborative patterns similar to the ones explained before.

As a result, the tool remarks the most important expert due to his number of messages and events, besides his evolution through the months analyzed: "*Now Bruce knows who the experts he was looking for are. Specifically, he knows that Ben is the greatest expert of his new department in the cloud computing area. Therefore, once this awareness has been generated for Bruce, he could now talk to Ben in real time (using the chat and videoconference tools provided by the Nuve module), follow his conversation threads in the forum or join the next events organized by Ben in the Agenda and Calendar component*".

B. User Acceptance

Once the test users known the previous general scenario, the evaluation was carried out using an online questionnaire with several properties that users had to score in order to examine the user experience of CollawareSoft. To do this, the test users were asked to judge some statements related to those properties using a 5-point scale, where 1 mean "totally disagree" and 5 "totally agree". The statements were like this: "*CollawareSoft is [property evaluated]*".

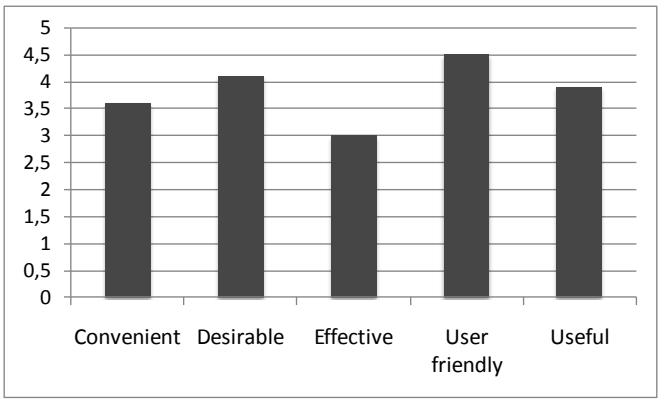

Figure 6. Evaluation results of user experience.

Additionally, users had free text inputs fields to make comments and annotations. The results are illustrated with average values in the Figure 6.

VII. Discussion

The first results obtained show that despite this kind of awareness tools are usually unknown for standard users, after several days of using it, they consider the application a desirable tool to enhance their daily collaboration.

On the other hand, and related to the comments written by some of the test users, they remark that the application started to give them information after several days, and also, this information was not very precise at the beginning. This is related to a well known problem called "cold start". These kinds of systems based on social data need some time and data to reach a proper collaboration activity in order to be able of generating social awareness. This is so because despite the Experts search engine is capable of generating the social network patterns, the temporal structures need a continued use of the platform to appear. Therefore, this clarifies why the score of the "effective" property is the lowest one.

Last but not least, a great majority of test users remarked in their comments that they liked the application look and feel (represented by the "user friendly" property). As Miller said in [18], design can play a critical, and even primary, role in determining which products stand out. Therefore, in our case it is an important factor to avoid losing users after a first contact with the application, because we need from them a long experience with it in order to enhance the awareness generation, because the more social data we have, the more efficient will be the expert recommendation.

VIII. Conclusion and Future Work

We have built a web application called CollawareSoft capable of providing collaboration at different levels and generating awareness to provide users a more complete social and collaborative experience following the RIA paradigm. Therefore, throughout this article we have shown the main features of the Client-Server architecture built, and the different techniques we use to generate awareness from the social data resources stored in the server side. Afterwards, we have demonstrated that problems such as looking for knowledge in a company can be solved. Hence, this tool is capable of analyzing social data to create social and temporal patterns that we can combine in order to achieve complex patterns (or macro patterns) that provide rich awareness.

In addition, a light evaluation focus on the user experience and the expert search engine we have build based on the awareness generation has remarked that the user considerer the application useful and desirable for their daily collaboration in a business environment.

We can also talk now about future lines of research that we have identified.

Firstly, discovering new methods and algorithms to analyze relationships among users using social data are important areas where we should work in the future in order to include them in our application. An interesting way of improving the awareness generation is based on using clustering algorithms usually used in recommendation system. Applying clustering processes (e.g. K-means [19], Canopy [20], Spectral [21], etc.) over the social data we store in the SRI could be a good solution to discover similarities among CollawareSoft's users. Consequently, using these methods we could create social clusters that identify knowledge areas inside the company, making easier to discover the social ties among users.

To do this, we would need a rich information or profile about every user in the company or collaboration group (e.g. experience background, projects in which he or she has taken part, knowledge managing by workflow technologies [22], etc.), in order to be able to calculate suitable social links or ties among them like is done in [23] through keywords that represent user's "know how".

To achieve this requirement, we think that it is also important to work in the second research line described in the following lines.

Regarding the ideas proposed by the Social Web Incubator Group of the W3C, specially the Socially Aware Cloud Storage concept [24], that tries to achieve a way to re-architect social network applications (e.g. Facebook) so as to use their user's data by third parties, we have an interesting research area. If we think about the present Social Network Site Silos where every social network has its own user's data only shared through specific APIs, we quickly understand that it is necessary a way to achieve a common architecture to share these user's data, allowing third parties to use them in a cloud computing way.

Thus, we believe that if this kind of architecture is achieved, we could use it in the future to join the social data that a user has in these social networks with the data that is allocated in CollawareSoft, achieving a more complex and rich awareness of this user, to provide him a better collaborative and social context. So, to conclude, we assert that joining the user's social data from the personal and business worlds will probably give us, in the future, a powerful way to generate awareness.

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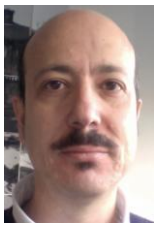

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