Pervasive Services, Collaborative Work in Situation of Mobility

Kahina Hamadache, Patrice Manson, Luigi Lancieri
France Telecom R&D
{kahina.hamadache, patrice.manson, luigi.lancieri}@orange-ftgroup.com

Abstract

In this paper we present a pervasive service to enhance the collaboration between members of a community. This service allows scattered users using various communication devices (PDA, Smartphone, computer...) to communicate and work efficiently. To provide an ergonomic way for people to collaborate, we propose a system of pervasive brainstorming based on the use of SOMCQ.

Keywords: Pervasive Collaboration, Pervasive Brainstorming, Pervasive Services, Online Questionnaires.

1. Introduction

The notion of pervasive services extends the notion of pervasive computing [15] in a sense where the scope is at first focused in the interactions between the technology and the users. Human behavior is indeed a key element in pervasive services. Hence, the question is not only how granular and spread computer resources can communicate in an enhanced way and produce added value, but also how such framework can interact with end users with a high level of adaptability whatever their location or their needs.

An example of pervasive service is that of pervasive learning [14] where one of the goals is to allow the user to have a learning activity imbedded in a continuum of his every day activities. In such perspective, the user does not need anymore to change location, devices or break the flow of its present activity to add or consolidate his knowledge.

Pervasive services ideally based on pervasive computing can extend and enhance all kind of services based on mediated communication between users.

In this paper we develop this concept through a review of the literature as well as the presentation of an example of pervasive service we have developed: P-brainstorming (Pervasive Brainstorming based on E-Brainstorming principle [1]).

The goal of P-brainstorming is to allow enhanced and ergonomic cooperation between mobile users. One of the main ideas brought back by this concept is that the initiator of the cooperation facilitates the contribution of other members of the group. This is allowed; in particular, thanks to the use of semi open multiple choices questionnaires (SOMCQ). We will see that such approach is able to channel the mechanism of collective intelligence [17] in an ergonomic way. This last point is important since the ergonomic of mobile device is not yet very high.

Through the example of P-brainstorming we review the literature of pervasive services in order to discuss some path of evolution.

This paper is structured as follow, in section 2 we describe the design of our P-Brainstorming system. Related works are presented in section 3. In section 4 we present an evaluation. A discussion on the advantages and the limits of our approach is presented in section 5.

2. P-brainstorming: Service and architecture

Now, we present how P-brainstorming works and how it can enhance a use case.

2.1. Use Case and Needs

Let us imagine a use case involving a manager and his distant and spread working team. The manager is visiting a road show presenting new devices. He wants to have as soon as possible the main opinion of his team on the interest of the device for the company. Without specific system for collaborative work, he will have to try to contact directly each member of his team, by a phone call, a SMS or a mail. In the case where the team has his own forum, the manager will let a message, eventually with a questionnaire. Then, if his team is composed of a great number of members, he will certainly be forced to use paper and a pen to sum up the votes (in the case where there are note using a forum). In the other case, we will have to wait that member's check the forum for new messages. We can point out several defaults or lacks in the classic means of communications in the context of collaborative work in situation of mobility:

- Contacting each member of the team can take too much time or be costly;

- Except for forum surveys, we can't summarize quickly the opinion of the group;
- Forums, in opposition to mails, sms and phone calls do not contact directly team members.
- Mobile (such as PDA and smartphone) devices are not suited for comfortable web browsing.

2.2. Our approach

We propose both a collaborative methodology and a technological process that support it.

The methodology starts from the idea that questionnaires are ergonomic and effective way to collaborate in non comfortable situation (users not in face-to-face meeting, mobility situation, etc). The goal of the automatic process is to simplify the questionnaire creation and the reuse of results. This process is mail or sms based and allow in few words, users to post messages which will be transformed in questionnaire on a collaborative website. One other major part of this process consists in making a synthesis of user collaboration and presents it within ergonomic interfaces. This is a critical need, because we clearly know that synthesis are hard to achieve in collaborative situation and that an efficient service with an awful interface will be less used than a more classic service with a good interface.

2.3. With our system

Let's go back to our team manager. He still needs to have the opinion of his team concerning a new device. As he wants to have the opinion of each member of his team, the best way to do that is to create a questionnaire with a main question and a set of possible responses. If the manager is not too much in the hurry, he can create an open questionnaire, giving his members the opportunity to made additional comments. With our system, and given the fact that he only has a smartphone, he can simply write a mail with a simple syntax and send it to a specific mail box. Once this is done, our system automatically takes the mail, extracts the questionnaire and publishes it on the collaborative web site. Finally our system sends a mail back to the manager which informs him at what URL the questionnaire is available. The manager can then forward the mail to his team. Actually, this approach allows anyone with any terminal to collaborate with any groups.. After that, each member of the team can directly access to the new questionnaire and vote or/and propose a comment.

At any moment, the manager can access to the website to consult his questionnaire results.

Finally after few hours, the manager can have a synthetic formalized response from a large part of his staff, thus he can take a decision that will reflect the opinion of the group.

Starting from these ideas, we have to think of how we can make mails, mms and forum-like sites interact. In the following part we will describe a system designed to enable those interactions.

2.4. Pervasive Brainstorming system

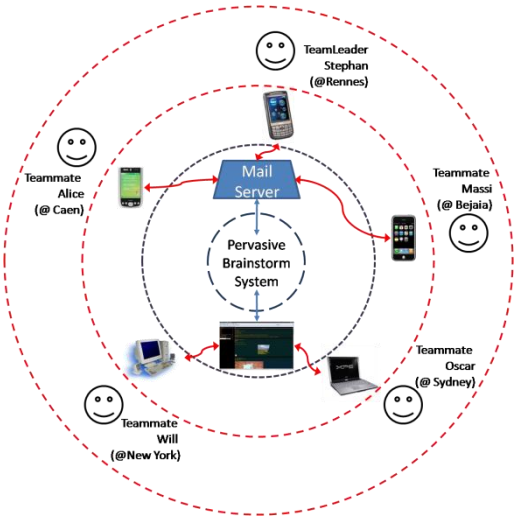

Figure 1 Pervasive Brainstorming System

Figure 1 represents how a team can collaborate around a simple system offering two simple interfaces: a web page and a mail box.

The main system has several functionalities:

- Collecting mails from the mailbox;
- Analysing and transforming these mails into html questionnaires;
- Computing averages of users answers
- Displaying questionnaires on the webpage as well as statistics results.

The outer layer represents the team community. As we can see, they're in different locations, do not have the same devices but have to work together.

The second layer is the representation of team member's devices, they're of different kinds and offer various connectivity.

The third layer is a reference to the different available networks and protocols built over them. (Internet, http, smtp, imap …)

The core is the pervasive brainstorming system itself allowing interactions between all members of the community.

2.5. Publication of Questionnaire.

Let's have a look at the questionnaire publication service.

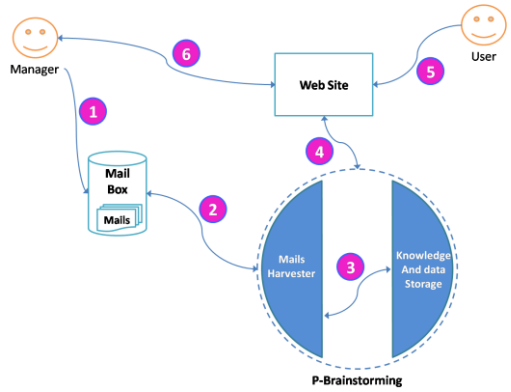

Figure 2 Questionnaire Life Cycle

Figure 2 shows the life cycle of a questionnaire with our system.

- The first step is to compose a questionnaire with a communication device and a mail client. To be sure that the questionnaire will be correctly interpreted by the service, you need to respect some simple syntax rules and you must use the set of predefined tags (e.g. [Q] for a question and [R] for possible answer). As this rules are quite simple and not too numerous, we assume that someone can use it almost naturally.
- Once the questionnaire is composed, you have to send it to the mailbox of the p-brainstorming service.
- The step number 2 is the harvest of the mails by the system.
- After that the system analyses the mail, extracts the questionnaire and stores it in the data storage (which will be described later).
- The questionnaire is converted to HTML and published on the website.
- The fourth step is the vote of users. They can access to it directly by the link in the mail you have sent (or forwarded) to them.
- Finally, you or any member of your team can access to the results of the questionnaire.

2.6. System architecture

After a general overview, let's have a closer look at the core of the system. We'll see which components are used in our system.

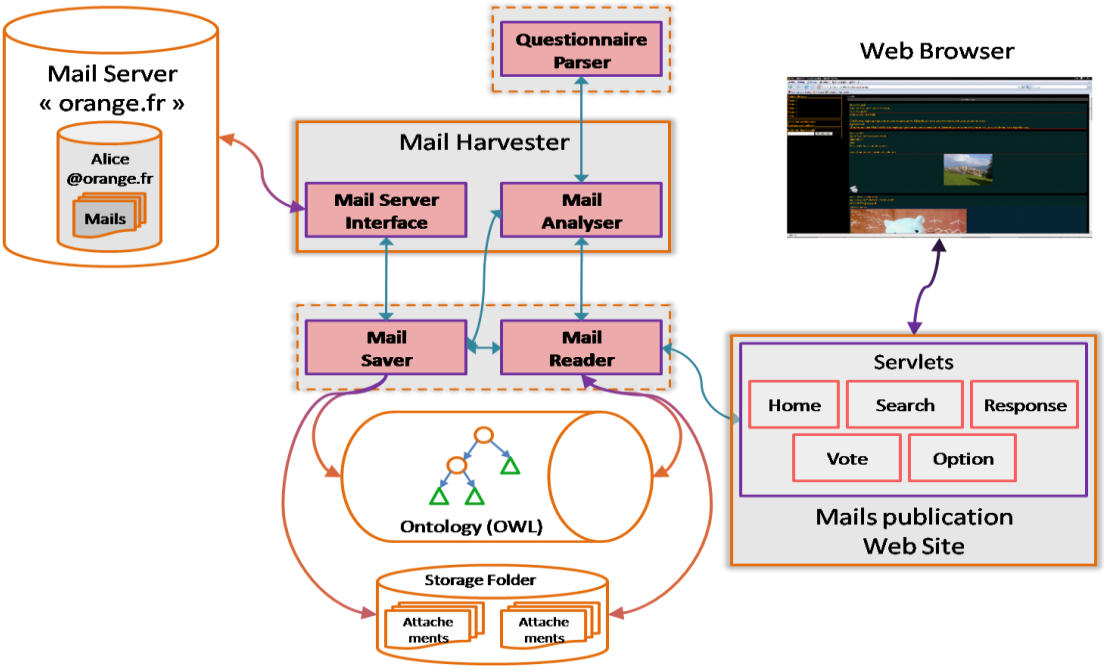

Figure 2 System architecture

Figure 3 shows the architecture of our system. The system itself is composed of the following parts:

- **Mail Server:** a classic mail server.
- **Mail Harvester:** a composite component in charge of collecting and fetching mails from a mail server.

- **Mail Server Interface:** the interface between the mail server and the mail harvester. We used the JavaMail API to build this component.
- **Mail Reader:** a component in charge of reading mails from our ontology.
- **Mail Saver:** the component in charge of saving mails (in the ontology and the attachments in the correct folder).
- **Ontology:** the ontology in which we save mails' structures and links to attachments. We also use it to save questionnaires. We use an ontology, because we know that in future works, we'll need it to represent information.
- **Storage Folder**: a folder to store mails attachments and textual contents.
- **Publication Web Site:** the website where mails and questionnaires are published. It is composed of a set of Servlets.
- **Questionnaire Parser:** a mail content analyzer. It parses the textual content of the mail and extracts questionnaires from it.

We base our system on the use of an ontology. In order to do that, we developed a simple ontological model to represent mails and questionnaires. We rapidly get a problem when we tried to store them. We first thought that we could save to whole structure of the mail and only access to useful content at the moment of the user request for display. However, with this method, we needed to compute the interesting parts of all mails each time we want to access it. We clearly know that this is a too heavy task and that this is not realistic for a simple display. To solve the problem we decided to store the mail according to two different "facets", which are different representations of the mail. Figure 4 shows a part of the structure we use to store mails. The first facet named "raw" stores the whole mail with its structure (headers, body-parts…). The second facet called "front" is used to store important information, such as mail subject, sender, recipients, sent and received date, mail textual content, images and attachments (their URL). Questionnaires are also represented in the ontology; to do it we have a simple model: we define a questionnaire as a set of "Questionnaire Atoms". These atoms are composed of a question, a set of possible response and illustrating images.

There is another reason why we need this ontology: our desire to integrate a context management module to the system. This part of our future work will be based on different works that use ontology to model and reason on the context.

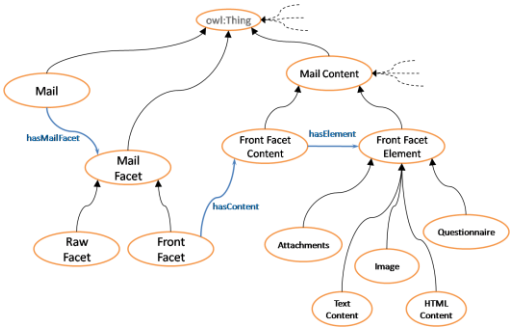

Figure 4 Mail part of the ontology

The functioning of the service is simple, a mail is sent on the mailbox. Our *Mail Harvester* periodically checks the mailbox for new mails. New mails are analyzed, parsed and put on our *ontology*. The content of mails (text, images, sounds, attachments…) is stored in specific folders. Once this is done, the service sends back a response to the sources of the mail with the computed link of the "mail" or questionnaire on the site.

Once the system has finished its update, mails and questionnaires are directly available on the site.

The voting system isn't complex. A user visiting the website can answer to a questionnaire by choosing a response. The system then updates the questionnaire in the ontology, and this is done.

3. State of the art

In this section we mention existing tools developed to support collaborative work. Many systems have been proposed for providing CSCW (Computer Supported Collaborative Work).

The first IT tools helping individuals to collaborate at work has been computers, office applications and storage media, followed afterwards by local office networks enabling mainly files transmission and shared repositories. The key revolution came with the success of the Internet by which multimodal communication between individuals, information/documents sharing and business portals over the Web have led to a basic global cooperative service infrastructure benefiting quite different communities.

In 1968, Douglas Engelbart realized the first collaborative system of the story NLS (oNLineSystem.) [3]. He tries with his team located throughout the United States, to prepare a paper on several hands. In 1969, the advanced Research Project Agency launches ARPAnet, the forerunner of the Internet, consisting of a network of 4 computers. The

adventure of the Internet and tools for collaborative work can begin.

The first collaborative product is only released in 1989 by IBM with its Lotus Notes.

Starting 90 years, the tools for collaborative work are increasing.

YACO [4] is a framework that offers services for supporting mobile collaborative work based on a publish/subscribe system. The purpose of this system is to exploit capabilities of SIENA publish/subscribe system with support collaborative work.
Khronika [5] is a centralized system implementing a client-server architecture. Mocca [6] proposes an architecture composed of a set of loosely connected components (called managers) which provide appropriate portions of cooperative support. MOTION [7] (Mobile Teamwork Infrastructure for Organization Networking) is oriented to manage user's mobility and is based on a peer-to-peer architecture. The system is composed of peers that communicate each other by using services offered by a middleware called PeerWare. Services offered by MOTION are: artefact storing in local repository, resource searching and sharing, messaging, system events subscribing.

Web sites as a whole also reach new stages in this collaborative framework. One example is collaborative content sites, which are focused on collecting information about a certain topic. The most representative of collaborative sites is Wikipedia, a wiki web site focused on collaborative writing a full free encyclopaedia in many languages. Others examples of collaborative web sites are news ones. Slashdot [10], Kuro5hin [11] or Digg [12] content is contributed by users, and it is published to the front page in several different ways, that range from editors control to users moderation. With the arrival of the next generation web environment, CSCW has taken one further step, which we call "Internet Supported Collaborative Work". Web 2.0 provides an incredible framework for collaboration. [13] proposes a Web collaborative Architecture centred on individuals. It involves the Personal Collaborative Framework, a set of web tools that integrates the following actions: publish, subscribe, search and site collaboration.

[1] proposes a methodology allowing the generation and the use of online multiple-choice questionnaires to enhance collaborative work. This work is mainly based on the use of small tags such as "q-", "i-" or "r-" to generate questionnaires from a simple mail.

Collaborative process in situation of users' mobility can be found in several contexts. [8] proposes a web based multimedia collaboration system for medical image analysis, diagnosis and report, this system can provide easy access to the user using internet and also operating system independent. [9] presents a review of information and communication technology applications for collaborative work in construction projects.

[16] proposes a pervasive learning architecture, called GlobalEdu, built on a pervasive computing platform : ISAM. It is based on the use of two different components: Educational Service (ES) and Pervasive Personal Pedagogical Agent (P3A).

As in the stand alone computer era, we will face the paradigm shift leading to pervasive services. Indeed, the computer and telecommunication infrastructures are becoming more and more present and mature in our environment (mobile devices, RFID, Bluetooth...). The scope will rapidly focuses on: what can be done with such pervasive architectures.

4. Evaluation

Pervasive services for collaboration look promising, but there's one point where they are far more complex than classic services, the evaluation. [18] presents the fact that it is almost impossible to describe a full specification for ubiquitous services at the beginning of the design phase. They also raise the fact that we should rather develop a first model with essential and interesting functionalities and make them evaluate by users. Then, we make the service and the system evolve by considering users' comments. This method is called "Rapid Prototyping".

Another important point is the need for us to develop collaborative scenarios. Moreover, we will need to develop even more complex ones by introducing the fact that a user can be assimilated to a complex system. Indeed, in the future works, we will hardly work on the representation of the user's context, this will bring us to the fact that a user may have several devices (a PDA, a computer, a laptop). Such scenario will certainly offer great perspective, but we think that to design them we will need to "survey" users for services they'd like to have.

Hence, a key question is to propose evaluation methodology and indicators. We propose an online evaluation method reflecting the use rate of the system. The idea is that an efficient service tends to be appreciated by users and indeed used. For example in our system it is possible to monitor the questionnaire response rate (ratio between real

participant and solicited). We may also compute a utility indicator proportional to the number of participants and proportional to the number of questions. The idea is that it would be difficult to ask directly (e.g. phone call) a lot of questions to a large group. The reusability of previous results may also be monitored. These indicators and others (nomadic ratio...) may be visualised through a graphic board or results contextualised. This will provide a feed back for the services administrator but also for the service users

We also want to see how users turn out the services to use it in an unpredicted way, to do it we will need to let users use them for a long time.

5. Discussion

Even if it seems clear that future services will become more and more pervasive there are still problems to solve. One of the main difficulties we try to tackle in this paper is that of ergonomic.

The question not only deals with mobile devices that have the constraint of transportability which naturally limits their ergonomic capacity (i.e. small screen...). The end user device will most probably remain an unavoidable limit. This is the reason why we think that the ergonomic problem should be transferred from the end device toward the service. In other words the service (added functionalities, usage scenarios...) should compensate the limits of the end user device.

In the pervasive brainstorming, one of the ambitions is to simplify the interactions between the user and the mobile device.

Even if this approach seems to be interesting, it is not easy to identify till where the human machine interaction could be optimally simplified and displaced toward the service.

In further works, we will investigate this key question.

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