Experiments in ubiquitous computing for communities of practice using learning resources

Amel Bouzeghoub¹, Pierre-André Caron², Sarra Kaddouci², Claire Lecocq¹, Xavier Le Pallec², François-Julien Ritaine², José Rouillard²

(1) Telecom Sud Paris
9 Rue Charles Fourier
91011 Évry Cedex
Tel. : +33 1 60 76 40 40
mail@int-evry.fr

(2) Laboratoire Fondamental d'Informatique de Lille (LIFL)
Université Lille 1
59655 Villeneuve d’Ascq Cedex, France
tel. : (33)3 20 43 32 70 fax : (33)3 20 43 32 01
mail@univ-lille1.fr

Abstract

We present in this paper the interest of ubiquitous computing for the so-called contextualized forums. These forums allow communities of practice exchanging and sharing experiences or situations already lived by using learning documents to classify these exchanges. These forums contain a lot of information which contribute to improve classical training. We study here ubiquitous computing possibilities to use this type of forums in order to improve professional training to business process by helping the user to put his/her acquisition into practice. The developed application is being tested and works mainly on smartphones.

1. Introduction

In 1991, Mark Weiser, in a founder paper of ubiquitous computing (detailed below), has described the future of computer science over 20 years [1]. We live nowadays in a world partly described in that paper. Several clues of this revolution are wholly visible in our environment, from GPS car navigation systems to numerical cameras and other connected terminals. At the same time, the Web 2.0 keeps a successful breakthrough especially with communities’ features like blog, wiki, rss, etc.

Learning activity takes greatly advantage of these aspects mainly thanks to communities of practice where users share and exchange their experiences. Considering interaction abilities offered by ubiquitous computing, we can imagine richer interactions with the users. But it seems more interesting to have the possibility to immerse this type of community in situ. Our proposal lies at the heart of these two perspectives. This paper is structured as follows: in section 2 we study how to articulate ubiquitous computing and Web 2.0 forum type applications. We present in section 3 the experimental framework of our research. In section 4 we describe the conceptual architecture of our proposal and we conclude.

2. Ubiquitous computing in a learning context: Which possibilities of use for communities of practice

2.1. Forums to support asynchronous communication within a community of practice

Regarding communication aspects, a forum presents a lot of gaps or deficiencies listed in [2]. Among these ones, some of them are inherent to the "asynchronous writing" character of the generated communication. Forums are thus somewhat adapted to the construction of a common support of knowledge or to support the life of a community of practice [3]. In addition, the forum has difficulties to overcome ambiguities resulting from the mediation of the communication [4]. Finally, it presents several limitations for a pedagogical use [5].

This imperfect tool is however used to organize the communication around communities of practice. This paradoxical use is only visible. Indeed, it is possible to
reconsider the forum tool according to specified
criterion in [6]. These criterions such as "feeling of
membership", "common interests", "feeling of social
presence" may be introduced by additional
functionalities in the forum. Each tool implements
specific functionalities to carry out the criterion
formulated by Jenny Preece in [6]. In the next
paragraph, we give examples of "contextualized
forums". Such forums enable to avoid ambiguities due
to asynchronous communication.

2.2. Communities of practice around the
document

Among several uses of forums, we are interested in
this paper in documents centred forums used by
communities of practice. Such communities use a
forum as an asynchronous support of communication.
This forum is mainly used to host discussions about
specific points of a document or documentation. Thus,
the Wikipedia community proposes on the left side of
each article a forum to resolve its raised conflicts or
questions. Ubuntu community works also with this
articulation Wiki/Forum: a debate already initiated and
solved in the forum generates an editing in the Wiki.
These two examples consider learning on the forum as
a construction of knowledge which may be stored at
the end of the process. Recent research seems to be at
the beginning of emergent usages and tools in the
frontier of the forum and the wiki. Finally, a last
example is suggested by PHP community. This
community proposes at the bottom of each page of
PHP manual a forum which enables users to submit
examples or report manual mistakes. By using these
types of sites we quickly notice that forums are mines
of information and are often more relevant than the
document content itself.

In a scientific point of view, forums used by
communities of practice are built around the
production of documents and/or comments. This may
be associated to the notion of "contextualized forums"
introduced by [7] where the forum content is displayed
depending on the activity carried out by a learner.
Sébastien Georges has imagined a tool CONFOR
(CONtextual FORum) which allow associating a track
discussion to a learning activity. The forum has
several views: a general view where all tracks are
mixed and a contextualized view where the learner can,
by accessing to a learning activity, access to related
tracks of discussions. The author showed that such
forums are universally-acclaimed by learners. The use
of the contextualized view enables the forum to
explicit ambiguities inherent to this type of
communication.

2.3. Towards in situ learning for contextual
forums

Feeds of contextual forums are constructed around
documents. In our current experiment, we take
advantage of this configuration to complete learning
documents by providing examples. All posted
messages contribute to define the current cognitive
state of the community: questions refer to domain
problematics, proposed solutions refer to concrete
experience, etc. "It seems evident and undeniable that
exchanges in a forum vary according the learning task
or situation in where it takes place. Participating to a
forum is an in situ activity which is finalised and fitted
to a context." [2]

Our works aim to reinforce and to use this in situ
feature. In our experiment, we complete context
elements by information gathered by external mobile
devices. Thus, contextual forums are not only
associated to learning documents but also directly fed
by messages that are composed in situation through
mobile devices. These ones propose relevant types of
data: photos, GPS coordinate, audio record...

2.4. "Everyware"

Since several years, we are seeing the miniaturization
of electronic devices and their integration into
everyday life objects. For example, mobile phones are
almost all equipped with a good quality camera,
diverse connections to networks (WiFi, GPRS…),
"free hand" feature, etc. With some kinds of personal
assistants (PDA) that use GPS, users can be helped and
vocally guided to follow a specific route. This trend
that consists on systematically digitalizing resources
enabling access to data needed anywhere, anytime is
sometimes called, in the literature, ubiquitous.
However, there is a wide variety of terms used to
describe this paradigm that is opposed to the more
conventional desktop metaphor (one computer per
person). This is known as ambient intelligence,
ubiquitous and pervasive computing. This refers to the
increasing use of widespread processors that exchange
small and spontaneous communications with each
other and with sensors. Thanks to their much smaller
size, these sensors will be integrated into everyday
objects, until it become almost invisible to users.

Indeed, as Mark Weiser explains: "The most
profound technologies are those that disappear. They
weave themselves into the fabric of everyday life until
they are indistinguishable from it." [1], [8]. He gives
here a first definition of pervasive computing. The pervasive computing refers to accessing the same service through various channels of communication, such as a desktop computer, a PDA or even a phone to use voice, phone keypad (DTMF) or SMS, depending on the needs and constraints of the user.

Adam Greenfield, meanwhile, uses the word "Everyware". This word, formed from "everywhere" and "hard/software" is a neologism to encompass the terms of ubiquitous computing, pervasive computing, ambient computing and tangible media. He explains in more details his thought: "When I talk about surfacing information that has always been latent in our lives, I mean putting precise numerical values on one present location, on what task we might happen to be currently engaged in, and in whose company; even on things like daily caloric intake or voice stress or urine chemistry. I mean making those values broadly accessible. I mean permitting operations to be performed on such values or aggregations of same, such that algorithmic guidance and control can be installed."[9].

2.5. Benefits of everyware in our context

Everyware increases abilities of a computer system to interact with reality. Adopting such engineering would benefit significantly to contextual forum (previously mentioned):

- Contextual forums would be better exploited in areas where practical application is rarely used in a computer. All types of situation are concerned, from simple ones – like assembling furniture – to complex ones – like repairing a telephone exchange.
- When a user will expose his/her problem, computer capture abilities allow a better diagnosis of the situation. Indeed, user can improve the description of his/her problem with capture devices of his/her mobile terminal (photo, video, audio record...). But other types of information should be exploited: physical and emotional condition of user and persons who surround him/her [10], identification of environmental and physical elements (for example through RfiD tag)... Computer capture abilities will also allow describing a better solution.
- If users may react faster to exposed problems, we could consider that number of responses will increase and their latency will decrease. Nevertheless, working/activities conditions of user may limit previous benefits.

It seems logical to also consider new social perspectives, like the advent of Web 2.0.

However, we have to consider some constraints of everyware. First, the ones of mobile terminals:

- screen size which are generally small
- long messages writing which is usually difficult
- network which is currently less reliable and fast
- storage capacity and power which are lower.

Second, the ones related to possible mobility of user:

- reading all propositions (of response) in a short time
- giving propositions after perusing a section and browsing the associated forum: will mobile user have the time to propose a solution to a problem she/he has already resolved?

3. Our proposal: support the transition between training and practicing in situation

In collaboration with a company which is an industrial partner in the P-Learnert project[11], we have designed an application based on contextualized forums. Experiments in real situation will start soon.

For our partner, the main objective is to study the possible usage of ubiquitous computing in the company’s training standard methods. When analysing training steps practiced within the company, we point out that the reinforcement of knowledge, acquired during a traditional course (i.e., in a room and with a tutor), by practicing in a real situation is a critical and costly step. Rather quickly, it appears that this step could benefit from ubiquitous computing. For this reason, the prototype that we are going to test aims at assisting the employees to put into practice the new process or methods recently learned.

To complete successfully this assistance, each employee, when back to his/her office, disposes of:

- a smartphone containing a contextualized forum application. The learning content is improved with mini-forums and consists of methods which are the main offered trainings
- a tutor who is a qualified person specialized in certain methods. Every tutor has the same type of smartphone so as he/she is able to answer completely or partially to "learner’s" problems. When the learner encounters a problem, the associated tutor is expressly notified.

The participation of qualified persons removes the constraint discussed before on user difficulties to be
available to answer the questions (find time): here the company’s chief asks some of his employees to participate to the experiment.

To summarize the application principle as illustrated in Figure 1, we can say that when an "employee - learner" encounters a problem about a "new" technique (fig 1, step 1), he/she can see the corresponding item on his/her smartphone. If his/her current situation does not exist in the standard description – the standard course–, he/she can look at the list of linked problems – concrete situation–. And of course, if he/she cannot find any similar situation, he/she can add the new encountered situation to the existing list (fig 1, step 2). He/she may want to request help immediately to solve his/her problem. This can be done through sending his/her colleagues a message (fig1, step 3). These persons can provide at different moments: a break, a waiting...

The next figure shows the home screen of our application and the report a problem screen.

4. Architecture

4.1. Learning documents and associated forums

We can identify two main problems in our experiment: technical constraints (display size, storage capacities, processing power) on one hand, and time constraints during real situations (not enough time to explore methods and "concrete situations"), in another hand.

For this reason, we decided to adapt the delivery content to the user context. The user context includes all the information about his/her profile: (1) his/her general preferences (e.g. favorite language, media), (2) his/her activities (e.g., information retrieval, trainings, see concrete situation), (3) his/her knowledge and environment (e.g., technical characteristics of his/her device, wired network, location). The user profile may be enriched by small fill-in questions given regularly. The context adaptation requires a semantic description of learning contents: during adaptation, only learning content corresponding to the real context of the user are selected.
Unfortunately the robustness of WM6 is not yet confirmed and it generally requires using expensive smartphones. Finally, it seems that .Net for mobiles does not fit very well with rich clients of web applications because it does not provide a basic implementation of SOAP and XML-RPC protocols.

In the meantime, our industrial partner started another experiment with Nokia E65 terminals based on Symbian OS. This "economical aspect" has offset the fact Symbian is less spread than WM and led us to choose this platform. Symbian presents reliable advantages. First, it provides a complete and proper access to capture devices from several programming languages like Java, C++ or Python. Then it offers a basic implementation of SOAP protocol and an experimental one of XML-RPC. Finally, Symbian is currently hosted on cheap smartphones and has already demonstrated its robustness.

Pedagogical content (i.e. common processes and related information) and associated practical applications are on the server side. The content management system Drupal [12] is the infrastructure of this side. It's SOAP and XML-RPC compliant system. Features of Drupal which are relevant for our application are the following ones:

− Collaborative books. Pedagogical engineers write pedagogical content through these structured documents.

− Blogs. Employees write their experience and especially their problems in log books which are supported here through blogger functionalities.

− Forums. This functionality is needed to support discussions about practical problems. Each topic starts with an initial post which consists for our experiment in a practical problem coming from a log book. This initial post is so a « virtual » post. Replies or comments may also be virtual (i.e. coming from log books). A topic may be associated to different pedagogical content/section.

− Contacts. When an employee encounters a problem, she/he writes it on his/her log book and notices that there is a problem. While this blog post becomes an initial post of a new topic, a notification is sent to other employees. These are persons that previous employee has declared to be capable to propose solutions to his/her recurrent problem – generally, a supervisor and near co-workers. Contacts module is used to define such lists.

Changes we have implemented in Drupal concern forums/blogs junction and notification mechanisms (with SMS and email). The main part of development is located on the client side. It aims to provide to each employee a log book-like application. In this application each post may reference to and be attached to pedagogical documents about common processes and/or may be the topic of a discussion.

To adapt the delivery content to the user context, we associate metadata to each book item and blog/forum post. When an employee wants to look for practical applications related to a particular process, its mobile application request corresponding service from the server by passing the user context including his/her profile. The service then infers on posts/items metadata, user context and models. Models are described in the following section. Inference is currently done on an OntoBroker server [13]. This one is located on another physical server. This implies SOAP communication between Drupal and OntoBroker. Previously mentioned small fill-in questions are currently ad-hoc implemented.

4.2. The adaptation/profiling module

4.2.1. Modelization. In order to provide the display adaptation discussed before, it is necessary not only to model users (employees) but also learning resources (courses and concrete situations). This module is based on four models:

The domain model: we use an ontology to describe the set of concepts covered by the knowledge domain. This domain model is used as a referential to semantically index methods and users.

The user model: we propose to describe a user with (1) his/her preferences (languages, media …) which are modelled with a set of couples attribute-value; (2) his/her knowledge described with known concepts and qualified with a weight (user level for each concept). User knowledge are modelled with relations toward the domain model and will evolve dynamically and automatically as the user follows courses and acquires new knowledge.

The context model: we distinguish four context dimensions: geographic location, device, activity and environment which contain required resources (like services or learning resources), technical environment and time. Each dimension is performed by an ontology. Dimensions are linked by semantic relations that allow expressing the fact for instance that a user is in front of a building and uses his/her camera.

The resource model: a resource (or a document) is described with a set of metadata. These metadata can be classified into two main categories. The first one describes general characteristics (author, format …).
The second describes the semantic of the resource relating to the domain model. It includes content (set of domain concepts), a context of use (GPS coordinates, path covered through the course tree) and an acquisition function (test results to update the user’s knowledge level).

4.2.2. Adaptation. The adaptation process aims (for the moment) to select concrete situations which fit with the user and his/her context. In the short term, this process will also adapt the selected resources.

The resource selection is done in several steps like a tunnel: (1) learning resources are firstly filtered regarding user preferences (for example, all resources whose language differs from the user language are removed); (2) learning resources are filtered according to user knowledge as well as his/her activities (hence, resources which are not adapted to user knowledge are removed); (3) learning resources are then filtered according to the context (thus, resources which are not adapted to user device are removed).

Learning resource adaptation consists in a content revision followed by a content formatting. The content can in fact be updated at the end of the process (certain parts may correspond to knowledge already learned by the user and can be removed from the final content). Formatting the content consists of choosing suitable medias (according to the content itself and the user context) and defining presentation methods and its organisation (number of screens, screens content, transversal functionalities).

5. Conclusion

In this paper, we have presented a web application which is widespread within communities of practice: contextual forums. We have proposed a possible vision of these forums in the context of ubiquitous computing. This vision has been driven by practical application of processes freshly acquired during a traditional learning course. The two main points of our proposition deal with a better contextualization of exchanges – thanks to integrated capture devices of mobile terminals –, and there adaptation according to the user context and profile. We will conduct an experiment during June allowing us to validate and improve our proposition.

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7. References