Using Awareness to Adapt Working Group Environment: A Lightweight Virtual Awareness Card

Jean-Baptiste Aupet, Nabil Elmarzouqi, Eric Garcia and Jean-Christophe Lapayre

Abstract—**Working in a distributed workgroup is related immediately to the interaction support, different resources and collaborative tools operated by dispersed users. In another level, belonging to a groupware implies a heightened sense of awareness established in the groupware environment. We benefit from the different awareness information created in the workspace. We present a new mechanism providing adaptability to the group environment. This mechanism is based on the concept of Virtual Awareness Card (VAC). It allows different users a remote connection to the groupware environment with heterogeneous interaction supports, and provides an adequate workspace by exchanging properties information of the different deployed by the actors. The virtual card insures the adaptability of diverse sites involved in the Collaborative Virtual Environment (CVE) during synchronous and asynchronous sessions. We make use of three awareness directives to perform the VAC card's data: Convenience Awareness, Preferential Awareness and Restrictive Awareness. In accordance with the different dynamic profiles information, actors can adapt their interactions and use of multimedia and collaborative tools during the work session. To show how the performance of virtual card can be improved, we implement the VAC exchange mechanism in a telemedicine application and we discuss its features by developing diverse testing scenarios to display more its integration in a collaborative virtual environment and benefits in term of bandwidth, exchanged information, and proportion of lost network packets within a distributed system.**

Index Terms: **Adaptability, Awareness, Awareness information, Collaborative Virtual Environment, Convenience Awareness, Distributed System, Preferential Awareness, Restrictive Awareness, Tele-diagnosis, Tele-medicine.**

I. INTRODUCTION

Collaborative Virtual Environments (CVE) are in expansion these last years, thanks to the improvement of the communication links and networks capabilities. The possibilities offered by these environments are in grown-up evolution and will be in adequacy with the needs of the users. To be efficient, we need to know at each time how to provide the good information at the good time. To do this, we develop a structured way to obtain information about all the actors of the collaborative work. This information allows the system to provide adapted environments to users in function of their needs.

Our approach focuses on the awareness of collaborative environment by promoting the interactive nature of the group environment and considering that the systems of interaction are systems of awareness [3]. We have singled out the awareness information as a key element [4] linked to the actor, shared objects, activities and full aspects of group environment.

In existing collaborative environments, users may register information of their environment such as their own preferences or the type of connection used to be linked to other nodes or to profit from a service. This kind of information can't be updated without human interaction. The concept of Virtual Awareness Card (VAC) will improve the management of the inquiries evolutions. VAC includes part of information such as description of the user and his preferences. The virtual card will give also more information about the user and especially related to his collaborative environment and how to be aware of him.

This paper focuses on the use of virtual awareness card in order to insure an adaptable and adaptive collaborative virtual environment. Nevertheless, awareness information involved in adaptability processes are related immediately to different situation studied separately, including several situations of using the collaborative environment through the shared workspace. An adaptable Virtual Awareness Card, which collects the evolution of user's information, could offer an updated data to adapt the environment in correlation with user's attempts and possibilities. We'll present the Virtual Awareness Card concept in Telemedicine collaborative environment to show how that concept can upgrade the efficiency of work. We'll also show its applications with scenarios and its implementation using a web service.

II. VIRTUAL COLLABORATIVE ENVIRONMENTS AND TELEMEDICINE

A. Virtual Collaborative Environments

Collaborative Virtual Environments (CVEs) are systems of interaction which allow multiple actors to interact among themselves and with their workspaces components. The particularity of CVE lies in their ability to offer a multitude of tools for users to share data and work on the same workspace. From user point of view, the collaborative session is the concept of co-presence of actors in time and space. The actors are, most often, represented by avatars which movements and behavior, a model and physical properties are allocated. The use of new technologies facilitates the access of actors to their work areas from afar. The co-presence of collaborators in synchronous session is designed to promote the group and to facilitate the access to communications between individuals

two by two or using multicasting protocols [2].

With advances in communication networks and processors power, the transition to the third dimension has been a great success. The integration of a multitude of ways to diversify the possibilities of human-machine interaction has become, notably, an obligation in the group environment. This obligation is explained by the heterogeneity of media access used by the actors: web, PDA, personal computer, desktop ... Providing an environment of immersion remains an ambition sought by the very common CSCW (Computer Supported Cooperative Work), especially as the themes addressed by CVE are very broad: distance learning, telemedicine, remote monitoring... This requires a considerable effort to designers of these virtual environments to put players in the proper environment to the treated theme and the scenario required by employees (meeting room, medical surgical room...). The recreation of artificial stimulation generated by the group environment in reality strengthens the work of individuals in the virtual world, dedicated to collaborative work.

B. Tele medicine

Telemedicine and eHealth are the use of electronic communication technologies as a method of delivering health care, education, and related services (medical imaging, distance teaching, patients files consultation). Dissolving barriers such as distance, time, geography, weather, and economics, applications are designed to bring services to clients rather than clients to services and improve the accessibility to the specialized health care, thanks to secured transfer of data. These applications give to practitioners the possibilities to exchange their information and experiences as they were in the same room to deliberate together [1]. CVE are environments that provide all the services to perform these applications.

Collaboration tools and awareness features are used to make new telemedicine software more efficient than classical software in term of collaborative work level. The goal of telemedicine is to allow practitioners to act as if they were at the same diagnosis table, using a varied panel of medical tools.

III. Virtual Awareness Card

A. Which adaptability needed for CVE?

A lot of criteria could change the system to accommodate with the users attempts, but the users won't lose their time to configure these criterions of the system, especially if they want to use the system with different terminal. For example with their computer in their house or with a public access point with a PDA... If users must change the configuration of their system each time they change of work environment, they quickly unused this system to avoid losing time at each change. Therefore the system must be adaptable, but to provide an environment that evolves with the attempts of the users [8], it will be adaptable and adaptive. That's the reason why we introduce the notion of adaptive systems. The difference between adaptive and adaptable refers to the extent to which users can exert influence on the individualization process of a system. Adaptable systems are customized by the users themselves [7], whereas with adaptive systems this process will be made automatically.

B. Concept of VAC

In CVE, several actors interact with each other in the group environment and via a multitude of media. Our basic architecture [4] centralizes awareness in the CVE. This helps users to be together aware of one another and acting on shared data. We move towards an "*Aware Collaborative Environment*" [6] that supports multiple levels of collaboration and offers a variety of tools to develop collaborative group work. We use this awareness information to address three important notions of awareness used in collaborative workspace, in favor of creating an appropriate structure for adaptability of the group environment:

*1) **Convenience Awareness**: accessibility to the group environment requires, in addition to an awareness-oriented working group, the medium adaptability according to the support used by the actor. The user, via his area of work, is aware of its medium and different media access used by all actors. We use the awareness information, in this level, to dynamically adjust the profile of the actor by his support. What determines the first generator field of the VAC. The actors adopt an awareness of convenience in access to CVE via the appropriate hardware medium for the actor (PDA, laptop ...),*

*2) **Preferential Awareness**: the handling ability of operations in the working group takes into account the adaptability to custom attributes of each collaborative site. We use the awareness information of actor's workspace to adapt the various collaborators to different preferences of actors available in the EVC. We feed the workspace of the actor with a workspace awareness that takes into account their preferences. What determines the second field generator of the VAC. The actors at this level opt for preferential awareness.*

*3) **Restrictive Awareness**: the involvement of adaptive actors takes into account the constraints imposed at each actor by the environment itself. We use the awareness information at this level to adapt the actor in question, and then the rest of the collaborators, with various restrictions imposed by the nature of the working homogeneous spaces that are connected (bandwidth, restrictive access to specially tool…). The actors adopt a restrictive awareness for their adaptability to the group environment.*

C. Awareness information for adaptability

We have limited awareness information handled by the VAC and that comes from the three kinds of awareness required for adaptability. We focus on four types of information:

-**Hardware**: Different terminal properties used by each user (CPU, RAM, Terminal type: PDA, laptop…),

-**Software**: referring to the list of tools installed on the terminal (videoconferencing tool, audio player, video player encoder and decoder…),

-**Network**: that characterizes the networks properties

involved in each medium (Wireless, Bandwidth, proxy configuration, gateway ...),

-**Multimedia**: on the appropriate configuration tools manipulated by the actor (codec, video configuration, GPU...),

As shown in figure 1, the VAC (Virtual Awareness Card) is designed using awareness information: convenience awareness, preferential awareness and restrictive awareness. The adaptability of the different sites of collaboration is achieved by the management and handling of cards assigned to each collaborative site. In this article we discuss the awareness information from each site separately, and regardless of his membership in the working group: Individual Awareness.

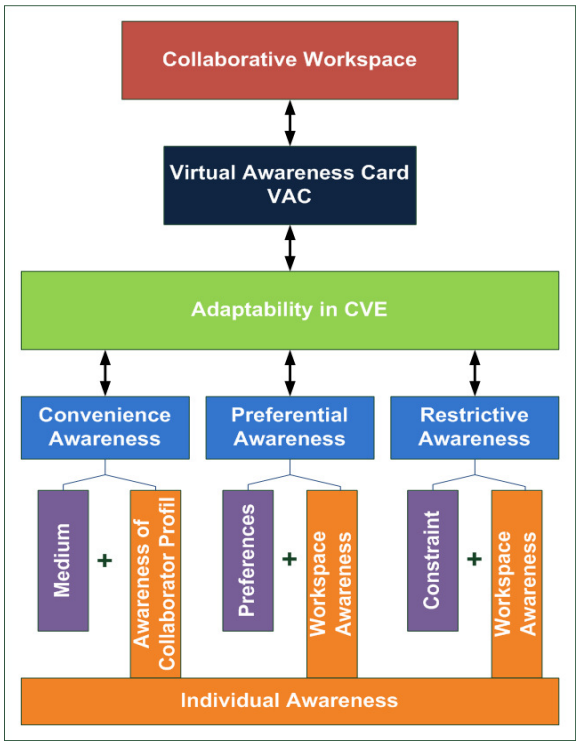

Figure 1: *Conception of VAC in CVE.*

A. *Adaptability information*

The virtual awareness card will be able to give information of the user but although information about the system. These information enable the environment to change and adapt itself to preferences and habits of users [5]. To provide an adaptable and adaptive system to the users, we must identify the most important criterions that interact with system and what criterions are significant for the interaction among system and users but also among users themselves.

There are two levels of adaptable and adaptive criterions, the Application level and Network level [9]. For both levels, we must show the relevance of criterions according to their utilities and their performances. In function of restrictions of the system, some criterions will be used or not. We will study which criterions will be required and those that will be optional.

In figure 2, we organized the information handled by the VAC with the XML structure.

```
<Properties>
<Hardware>
   <ProcessorArchitecture>
          . . .
   </ProcessorArchitecture>
   <RAM>
<memory>
   . . .
    </memory>
   </RAM>
   <VideoCard>
         . . .
   </VideoCard>
   <Terminal type="Laptop">
  </Terminal>
</Hardware>
<Network>
   . . .
</Network>
<Software>
  . . .
</Software>
<Multimedia>
  <Codec>
   . . .
  </Codec>
</Multimedia>
</Properties>
```

Figure 2: *XML description file of VAC.*

IV. Application

A. *Architecture and implementation*

To implement the virtual awareness card we've made an xml description file that describe the environment of the user with these preferences and these environment attributes such as terminal properties, network possibilities, mobility…

That is not an exhaustive description and lot of attributes are optional, it is possible to require some attributes according to the CVE necessities. In optimal version of VAC, these information will be auto-generated by the system when user change his environment or if he's on movement. We use also a web service who offers a bank of codec and tools to users for installing the good codec such as MPG4, H264 for video encoding/decoding or G729 for audio or for the same used tool (White board, ITK library for medical image processing) in all environment. An implementation of a web service using the virtual awareness card was done to test the performance of a streaming video server [10]. The page is coded with jsp and the web server is under Tomcat application Server.

We've got down to one's studies about three scenarios that

illustrate the use of virtual awareness card. These scenarios will show how users could take advantages of updating data with through his virtual awareness card. In this work, we have limited to study the impact of the diffusion of adaptabilities information's with the VAC in an existent CVE. The VAC processing should not affect the operations in the CVE.

We'll study the case of a practitioner who's travelling among several hospitals or directly visiting patients at home. He needs to be connected to his environment if he wants some helps to make a diagnosis or to attain patient's files. If he has at one's disposal an internet connected computer to access his telemedicine application or if he has only access with a laptop or a PDA with 3G connection, where he couldn't access to his application with the same functionalities. The presentation and the options accessible will be adapted to his work environment.

B. Uses of VAC illustrating by scenarios

To determine how the virtual card might act in the group environment to insure the adaptability of sites in collaborative work, we studied three different scenarios to evaluate the integration of this new mechanism. The common strategy referred to the integration of VAC is determined by the common workspace employed by different users from heterogeneous systems, and providing different features (multimedia, network ...). The distributed nature of the group environment we are studying, we orient immediately towards a distributed trading card. The establishment of a predetermined profile of each interaction support used by a user is not necessarily advantageous, since a user frequently changes its support that hold up remote access to the group environment, which remains very close to the situation addressed. In this article, we don't address the methods of acquiring awareness information used and needed by the VAC. We simply transfer the virtual card developed.

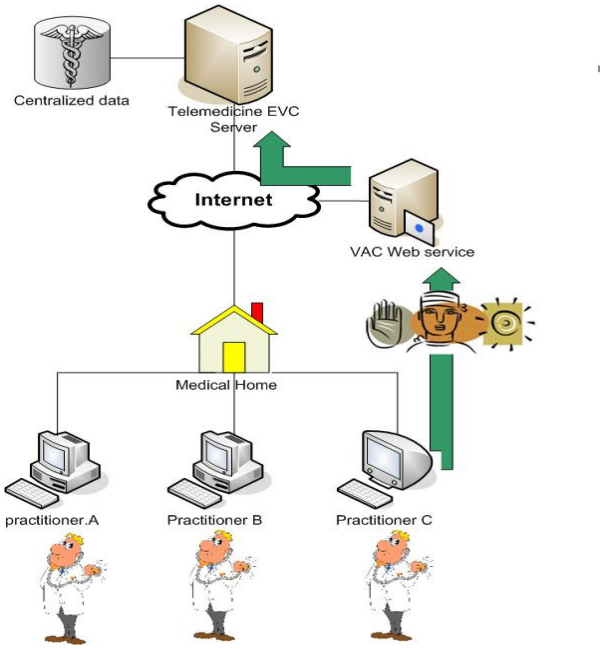

Figure 3: *Scenario A.*

Scenario A (figure 3): The practitioner A and practitioner B use the same environment (Computer and network) to consult patient's files stored in the centralized database server. They can log in the CVE of telemedicine to work and make diagnosis with tools offer by the CVE. The VAC will automatically harvest information about the hardware and software possibilities of the computer. Users have also saved their preferences (descriptions of user, see like, preferred applications…) using the VAC Web service.

The practitioner C owns a powerful multimedia computer that is equipped with devices and software with associate codec for multimedia applications. Automatically all these features will be detected and set in the CVE server, thanks to the VAC web service. Thus practitioner C can take advantage of CVE tools providing most level of interaction.

If practitioner A wants to enjoy new services offered by the new environment, he can log into the CVE with the powerful computer and he will automatically be able to use these tools.

Scenario B (figure 4): The practitioner A makes a medical examination at the patient's home. He needs to ask his colleague to make a diagnosis. He can connect to the CVE with his PDA and 3G connection. With the generated VAC sent to the CVE, the practitioner A can access to the patient's file and can benefit from available applications for this type of terminal and connection. He can collaborate with his colleague as if they were in the same room, as their habit. He can explain his diagnosis and show information about the patient. The VAC information allowed users to communicate with available devices and software.

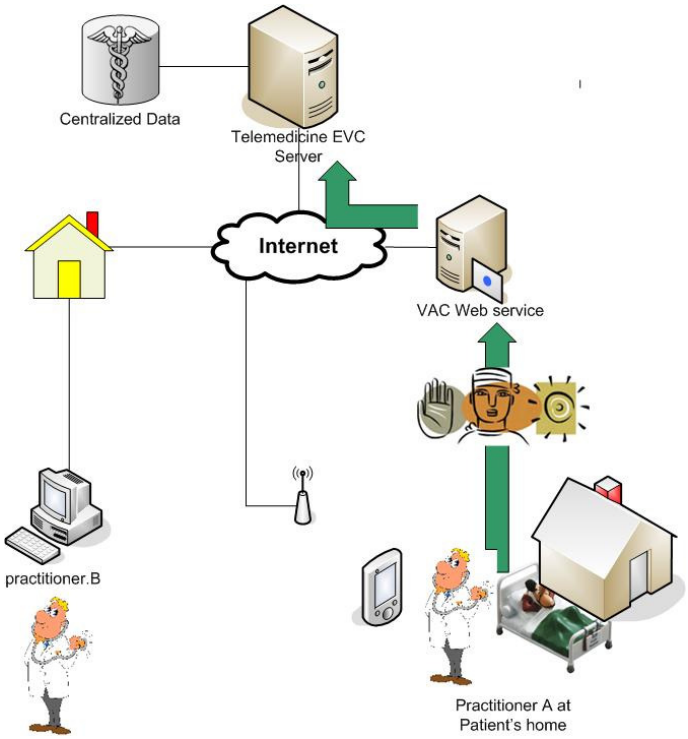

Figure 4: *Scenario B.*

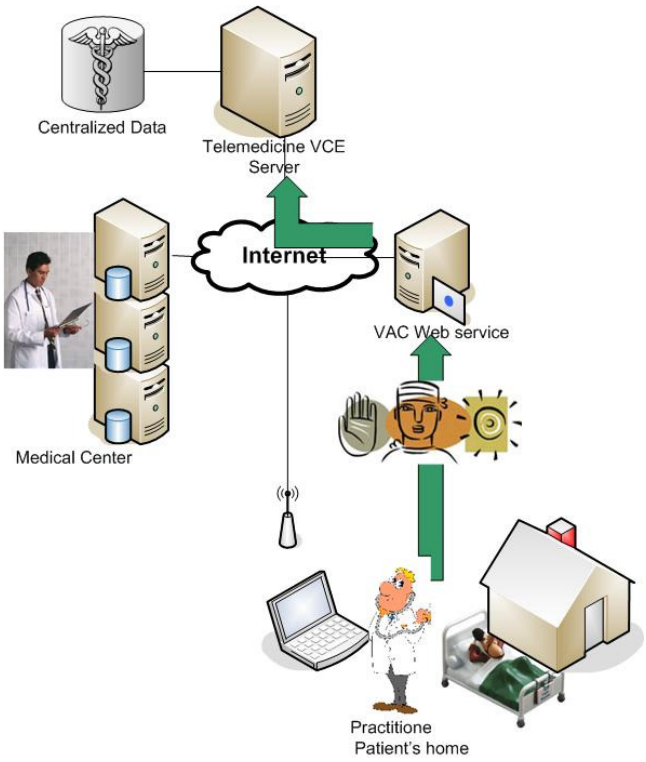

Figure 5: *Scenario C.*

Scenario C (figure 5): As in the scenario B, the practitioner A makes a medical examination at the patient's home. He needs the diagnosis of a specialist to determine if the patient is showing special symptoms. He uses his laptop with a wifi connection. When he logs into the telemedicine CVE, the generated VAC list the properties of his connection and his hardware and software environment. He's connected with a specialist of a medical center to collaborate on a diagnosis with the possibilities and tools of the medical center. The service has detected that the laptop is equipped with webcam. Codec and software are installed too. The specialist asks for the practitioner to use this equipment.

Practitioner can make a movie of an injury or a symptom and encode it with the good format supported by his colleague. They can exchange data on good format with the information diffused by the VAC web service and make a collaborative diagnosis.

V. PERFORMANCE OF VAC

To experiment the benefits of this concept we choose to make a simulation with the diffusion of VAC for each user. We have tested the mechanism of VAC with 6 collaborative sites. We have varied the frequency of updated awareness information between 1s and 60s in function of environment changes. We note that the size of VAC is of the order of 700 bytes. Each node receives the VAC of others according to different frequencies. We used the Soap protocol for exchanging data between the users of CVE. SOAP protocol allows developers to send and receive XML Data over HTTP. This protocol allows data exchange over proxy without specific port configuration. This mechanism will assure the access of data. In final version, this XML file will be automatically updated and diffused to each user by using centralized architecture. According to the results of simulation shown on figure 6, we note that both up and down speed remain negligible (about 5 kb / s) when the frequency of changing of collaborative site profile exceeds 6 s. This test shows that VAC diffusion doesn't affect the speed of the network.

In the figure 7, we have calculated the proportion of packet loss when VAC is used in a video streaming application. To adapt automatically the stream with the specification contained in VAC, the multimedia server adjusts the flow of data depending on hardware capabilities and bandwidth capacities in real time.

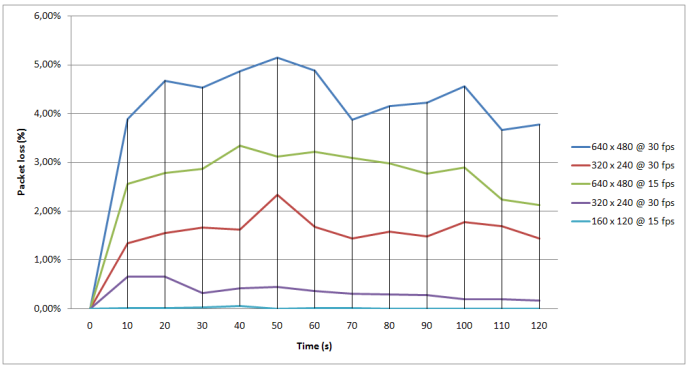

Figure 7: Packet loss proportion

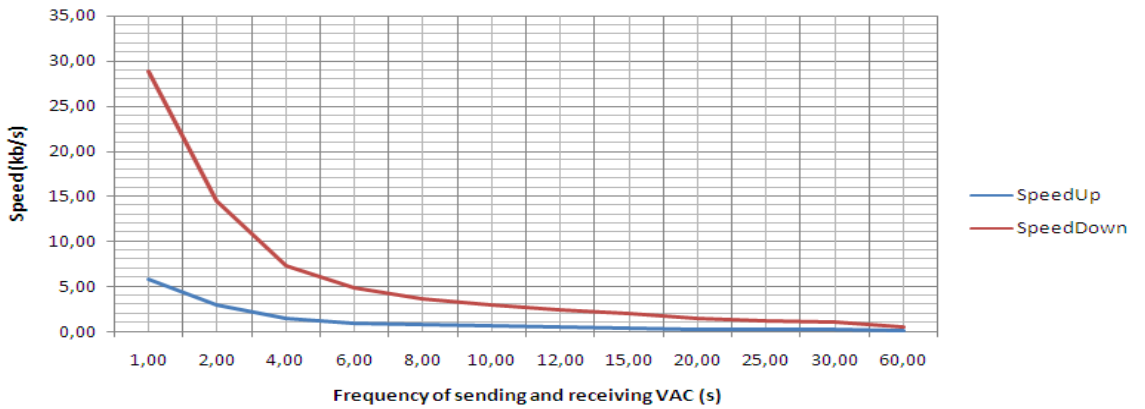

Figure 6 : Speed up and speed Down performances during VAC exchanges between 6 collaborative sites

VI. Conclusion and Perspectives

In this article we have introduced a new concept of adaptable awareness in Virtual Collaborative Environments provided by the virtual awareness card (VAC). We prove that card will increase the use of these environments by applying the best user-profile in function of these preferences but especially these hardware and software possibilities. The card can be used for a non exhaustive list of information. Information will automatically provide an interaction and the awareness of the others. Each user knows how he could collaborate with the other participants. The CVE with VAC updated information could adapt the environment and provide to the users exchangeable tools and data.

Perspectives: A way to increase the performance is to develop more awareness information used for the auto-generation of the card depending of the environment functionalities. With this kind of awareness information each user will be advised about the global awareness of the group. The diffused information will be used to adapt the virtual topology of the network in order to create an optimized overlay network to create a real distributed architecture.

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