THE ENJEUX-S ENVIRONMENT FOR REAL-TIME ONLINE EDUCATIONAL GAMES AND SIMULATIONS

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ABSTRACT

Funded by CANARIE Inc., the ENJEUX–S project (**EN**vironnement évolué de **JEUX** éducatifs et de **S**imulations en ligne) aims to develop a real-time communication interface that enriches the environments of educational games and simulations developed in the SAGE project (**S**imulation **a**nd **G**aming **E**nvironment for Learning). This interface allows for the exploration of a wealth of real-time interpersonal communications in educational situations which utilize online games and simulations. The elements of the interface are built on a Web services environment which rests on a SOA architecture. This novel approach permits universal broadcasting of games and simulations over the Web without any prior loading of software, assuring an increased accessibility of services, the interoperability of platforms and the re-utilization of components. The advances of the *User-Controlled Light Paths* (UCLP) CAnet*4 fiber optics network guarantee the ENJEUX-S project the instantaneity of communications and a wider visibility. The project is an extension of current work of the SAGE network. This paper covers the ENJEUX-S design methodology, its underlying architecture and its user interface.

INTRODUCTION

The ENJEUX-S project (http://enjeux.savie.ca) is being developed by a team of researchers of the SAVIE Research Centre (http://www.savie.ca) and is part of the ongoing work of the Canadian research network SAGE (http://www.sageforlearning.ca).

Online educational games and simulations, like video games on the Internet, are more and more demanding in bandwidth, in proportion to the integration of multimedia and communication components. The technology of CAnet*4 in the domain of fiber optics and high-speed links with the possibility of completely optical routing as well as optical bridges, permit the experimenting of applications that facilitate instantaneous and simultaneous exchange of large volumes of data.

The project goal is to develop a real-time communication interface based on a Service-Oriented Architecture (SOA) using Web Services connection technology. This novel approach permits universal broadcasting of games and simulations over the Web without any prior downloading of software, thus ensuring an increased accessibility of services, the interoperability of platforms and the re-utilization of components. By integrating the real-time communication components (video, voice, sound, chat, white board and online access management) into the environments of educational games and simulations on the Internet, the interface introduces the dimension of telepresence. This integration, which is one of the originalities of the project, permits the exploring of a wealth of educational situations (retroactivity, direct dialogue, immediate assistance, shared strategies, help, etc.), where the real world meets the virtual world to exploit situations in 2D or 3D, simple or complex. The development of this interface also has as objective to increase the communication and interaction capacity of generic multi-station game and simulation shells developed within the SAGE university portal as well as existing games and simulations.

1. THE DESIGN OF THE ENJEUX-S INTERFACE

In the first place our project uses a collaborative approach (Desgagné 1997; Miles and Huberman 2003) and a participative procedure (Floch'lay 1997; Mayer et al. 2000). Based primarily on the continuous collaboration between the developers and the parties implicated in the formative evaluation of the interface, this approach guides the evaluation protocol in order to associate the medium to the elaboration and validation of the interface on the one hand, and it favors the point of view of the users in the data collection process on the other hand.

The ENJEUX-S interface is being developed by adapting the *ADDIE* (Analyze, Design, Develop, Implement and Evaluate) iterative pedagogical design model (McGriff 2000), with a feedback obtained during the development

of generic shells for educational games by using the *Learner Verification and Revision* model (Sauvé et al. 2002) with both experts and small samples of the target audiences as illustrated in Figure 1.

Figure 1. Iterative Design Model for Generic Game Shells

potential partners of the final product's usefulness (Lauwereins 1995; Wirth 1995).

The main steps of this phase are:
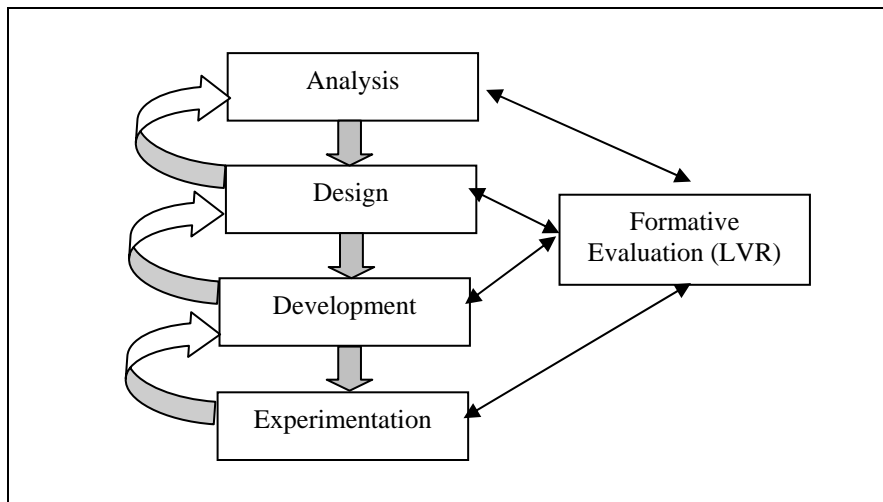• Infographic design of the environment;

The main development steps can be summarized as follows. A noteworthy point is the validation by the researchers as well as the partners associated with the project at every stage.

Analysis
• Analysis of the target clientele and the experimentation contexts;
• Identification of objects and functionalities;
• Pedagogical and technological specifications.

This step has been completed for all practical purposes.

Design
• Scenarization of the conceptual model;
• Writing of technical specifications;
• Scenarization of the screen pages and functionalities.

This step has been completed for the basic user interface; work remains to be done for some of the more advanced functionalities.

Development
We used the Object-Oriented programming approach (*Document Object Mode)* to develop the interface. It facilitates, among others:

(1) the rapid development of the application and its updating (Olsen 1995);

(2) the continuous revision and correction of the environment during its elaboration;

(3) the reduction of the time required for testing the final system; and

(4) the optimization of variable parameters in real-time, the evaluation of ideas and the convincing of the various

• Programming and benchmark testing of the different functionalities;
• Functional integration tests of the interface with a variety of games and simulations;
• Technological Beta tests (technical team);
• Development of contextual help menus;
• Language adaptation of the interface and validation with samples of the target clienteles.

The basic user interface has been completed and runs well in a multi-user environment; it has been tested extensively in teleconferencing applications. Work is underway for some of the more advanced functionalities. The use of standards defined by World Wide Web Consortium (XML, SOAP, WSDL and UDDI) allowed us to develop objects conforming to the norms and standards of accessibility, interoperability, reusability, durability and adaptability. They permit to envisage a complete ubiquity of services, making them accessible and transparent to the majority of users. Players simply enter the URL of the site to access a game or a simulation.

Implementation and Formative Evaluation
• Development of experimentation tools and validation with the targeted public;
• Experimentation in different environments: Several tests have been conducted successfully in the Windows and Linux environments;
• Gathering and analysis of data for program changes where required, and programming of all revisions;
• Final validation of the functionalities with the partners.

2. THE WEB SERVICES ARCHITECTURAL MODEL

The ENJEUX-S team has built an architecture that is essentially inspired by the development of Web services based on the SOA (*Services-Oriented Architecture*) model for the management and operation of games and simulations, and communication services (middleware) to support a collaborative work environment between users.

The diagram in Figure 2 shows the details of the SOA architectural model. This model is based on the following hierarchical layers:

(1) a **client** layer representing essentially the user interface, which contains two types of components:

- The real-time communication components (video-conferencing, audio and keyboard chat), developed with Flash in our project, are based on an underlying framework *(Component Framework)* that structures the functionalities of each communication component and links them to the nucleus *(Core Object Model)*, which manages the peripheral devices (microphone, camera, screen capture, etc.) and the main classes of the operating system using the FlashCom technology of Macromedia.
- The functional game and simulation components constitute the central portion of the client interface. They are composed of two types of products:

a) existing online games and simulations, the integration of which is transparent (independently of their development platform) and straightforward in our enhanced framework, and

b) games and simulations obtained from generic shells of SAVIE and the SAGE project.

(2) a **network** layer that transfers the data to the servers using the communication protocols and services of CANARIE's CA*net4, including bandwidth management with a multimedia and multipoint quality of service in real-time.

(3) a **server** layer containing two different types of servers:

- A *communications server* for the purpose of managing and transmitting in real-time the communications flow (video, audio, data) between participants. The communications server is based on the Macromedia Flash Communication MX Server which ensures the management of exchanges between the users and the communicational components developed in the project. An *access interface* connects the communications server to the data server in order to perform management tasks or requests.
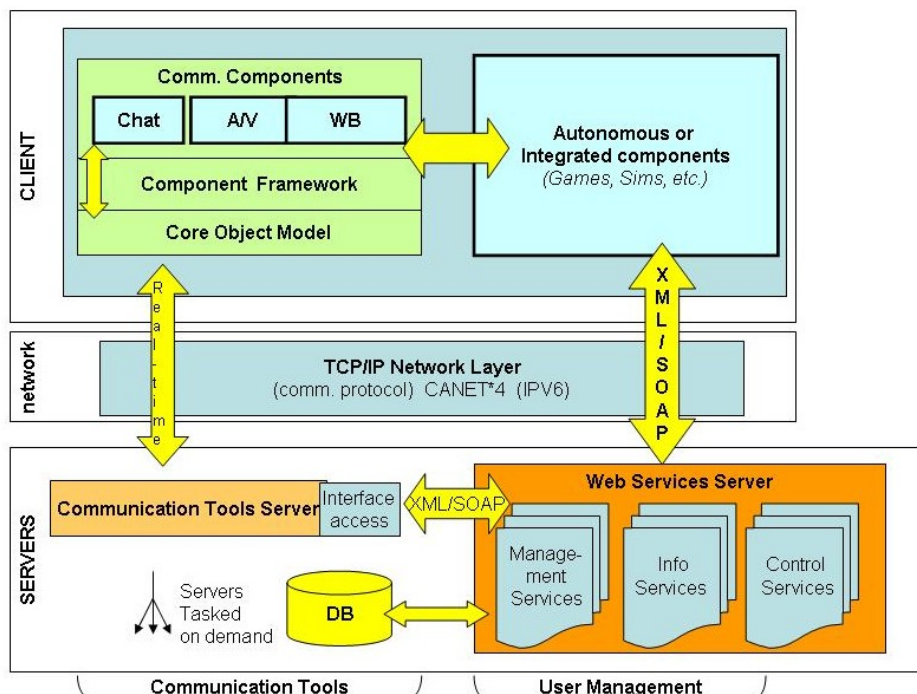

Figure 2. Model of the SOA Architecture of ENJEUX-S

- A *data server* (Web services) that executes the tasks or requests in a database. The database contains information on the participants and the status of games and simulations (profile, authentication of participants,

rules, movements of actors and objects, tally, etc.). Between the layers, the XML/SOAP language provides for encapsulation during an information exchange between two distant and different systems where a data

conversion into a universal language is required. This encapsulation is done in both directions during the exchange of information between the client and the server, hence its representation in the links connecting corresponding components of the architecture. The data server offers *management* services by processing requests related to the management of groups, of profiles and of user identification. As far as *information* services are concerned, they correspond to requests of the various components of the architecture. A number of *control* services permit the management of certain actions made by the users during games or simulations.

3. THE ENJEUX-S INTERFACE

Combining the functionalities of collaborative working (Villardier et al. 2003; Probst et al. 2004), ENJEUX-S offers an environment that supports, among others:

(1) online games and simulations;

(2) games developed by means of the generic shells of the Educational Games Central[1], three of which have already been implemented, namely Tic-Tac-Toe, Mother Goose,

and Snakes and Ladders (see details at the Web site http://www.savie.qc.ca/carrefourjeux/an/accueil.htm)
[1]Note: Five generic game shells have been developed by a team of researchers from SAVIE thanks to funding from the following granting institutions: NSERC (Telelearning Centre of excellence), 1995-99; Bureau des technologies d'apprentissage (HRDC), 2000-02; Francommunautés virtuelles (Industry Canada), 2000-01; Fonds Inukshuk (2002-04); a sixth shell is being developed with a SSHRC-INÉ grant (2003-07);

(3) games and simulations of the SAGE portal.

Functional, easily accessible and completely transparent to the user, ENJEUX-S uses Web services for the management and operation of online games and simulations, with real-time communication services to support a collaborative work environment between users. The only equipment required is a Web camera, headphones and a high-speed Internet connection to be transported into a virtual world of games and simulations. No downloading of special software is required.

Figure 3. A simulated screenshot of the collaborative ENJEUX-S environment

Among other things, while a game is being played, the ENJEUX-S interface [Figure 3] allows players to communicate in private or in public between each other by means of specific functionalities. This real-time communication may be done in audio or video-audio modes, in addition to video chat on demand. Each player can also, at any time, access a white board that provides information on the evolution of the game according to certain parameters such as: list of active players, current tally, status of the game, rules, configuration of the environment of other online players, etc. This interface

also offers different display modes that allow players to adapt themselves to the game or simulation context, and which they can parameterize according to their needs. Studies are underway currently to develop translucent objects in Flash, which would be superimposed on the background of the interface that constitutes the game proper. This solution would permit players to continue playing without exiting or loss of continuity of the ongoing game and to remain in full contact with the other players. On the graphical level, this solution offers the advantage of an improved visibility of the game or the

simulation, while conserving all the elements of the audiovisual communication.

CONCLUSION

At the completion of the ENJEUX-S project, an enhanced environment integrating multi-station games and simulations will have been developed, accessible through Web services that offer real-time communication components. Combining the functionalities of collaborative working, ENJEUX-S will provide a work environment for online games and simulations, games developed by means of the generic shells of the Educational Games Central and by the SAGE portal.

Functional, easily accessible and completely transparent to the user, our application uses Web services for the management and operation of online games and simulations, and real-time communication services (videoconferencing, audio and keyboard chat) to support a collaborative environment between users without need for downloading of special software.

The goals of our project are:
(1) the increased development and use of online games and simulations by educators for teaching purposes;
(2) the improvement in the quality of education;
(3) the accessibility to communities of learners in three languages (French, English and Spanish).

The project is innovating thanks to its Web-based environment that will integrate multimedia components, games and simulations. Furthermore, this environment will permit interactions between participants in real-time learning situations, and its users across Canada and worldwide will be able to discuss, make decisions and cooperate in many different ways.

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