Design of a Cloud Learning System Based on Multi-Agents Approach

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Abstract—**Cloud Computing can provide many benefits for university. It is a new paradigm of IT, which provides all resources such as software (SaaS), platform (PaaS) and infrastructure (IaaS) as a service over the Internet. In cloud computing, user can access the services anywhere, at any time and using any devices (Smart phones, tablet computers, laptops, desktops…). Multi-Agents System approach provides ideal solution for open and scalable systems whose structure can be changed dynamically. Educational institutions all over the world have already adapted the cloud to their own settings and made use of its great potential for innovation. Based on the analysis of the advantages of cloud computing and multi-agents system approach to support e-learning session, the paper presents a complete design and experimentation of a new layer in cloud computing called Smart Cloud Learning System.**

Keywords—*Cloud computing; Multi-Agents System; Project Based Learning*

I. INTRODUCTION

Smart Cloud Learning System is an hybrid approach that combine the Cloud Computing, the Multi-Agents Technology and the Learning Management System. In fact, Cloud Computing has become a popular topic in the research community because of its ability to transform computer software, platforms, and infrastructure as a service. Multi-Agents System approach provides ideal solution for open and scalable systems whose structure can be changed dynamically and asked cooperation, interaction and negotiation. Online learning is now a reality thanks to the development of Internet and to the virtual environments commonly called LMS (Learning Management System). But, to support the interactions of the various actors intervening in the formation (learner, tutor, teaching designer, coordinator...) and to propose the data processing tools and artefacts for their giving a support and assistance, constitutes today a serious problems, renewed recently by the explosion of the research on the e-learning.

In this paper, we present a complete design and experimentation of a new layer in cloud computing called Smart Cloud Learning System.

The first part of this paper introduces the design of a cloud learning system based on multi-agents approach called Smart Cloud Learning System (Smart-CLS). The second part presents the experimental results and discussion. We finish by the conclusion and the future work.

II. FROM CLOUD COMPUTING TO SMART CLOUD LEARNING SYSTEM (SMART-CLS)

Currently in literature, we can find several definitions for the cloud computing. According to the National Institute of Standards and Technology [1], "Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and is composed of five essential characteristics (On-demand self-service, Broad network access, Resource pooling, Rapid elasticity, Measured Service); three service models (Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS), Cloud Infrastructure as a Service (IaaS)); and, four deployment models (Private cloud, Community cloud, Public cloud, Hybrid cloud). Key enabling technologies include: (1) fast wide-area networks, (2) powerful, inexpensive server computers, and (3) high-performance virtualization for commodity hardware".

Cloud computing provides a scalable online environment that makes it possible to handle an increased volume of work without impacting system performance. In our sense, cloud computing can provide many benefits for university:

- Lower capital costs: University can provide unique services using large-scale computing resources from cloud service providers, and then nimbly add or remove IT capacity to meet peak and fluctuating service demands while only paying for actual capacity used.

- Lower IT operating costs: University can rent added server space for a few hours at a time rather than maintain proprietary servers without worrying about upgrading their resources whenever a new application version is available. They also have the flexibility to host their virtual IT infrastructure in locations offering the lowest cost.

- No hardware or software installation or maintenance

- Optimized IT infrastructure provides quick access to needed computing services

- User can access the services anywhere, at any time and using any devices.

In these advantages, many researchers of e-learning area [2] [3] [4] [5] [6] attempt to apply their process to cloud computing. It is one of the new technology trends likely to have a significant impact on the learning environment in recent years. However, the data privacy and security are the main risk[1] [7].

Our proposal revolves around three elements:

- Cloud computing must support e-learning and m-learning such as LaaS (Learning as a Service);

- Multi-Agents technology must be integrated in Cloud computing as a service;

- A new layer called Smart Cloud Learning System

(Smart-CLS) must be set, in order to provide services anywhere at any time and using any devices, for all actors in learning session.

Founded on these ideas, we propose the architecture shown in "Fig. 1". Smart-CLS is a layer of software that creates a common platform for all communications human-to-system, Web-based, and mobile-device-based interactions. Smart-CLS has two major benefits:

- Provide a Graphical User Interfaces agent (GUIs agent)

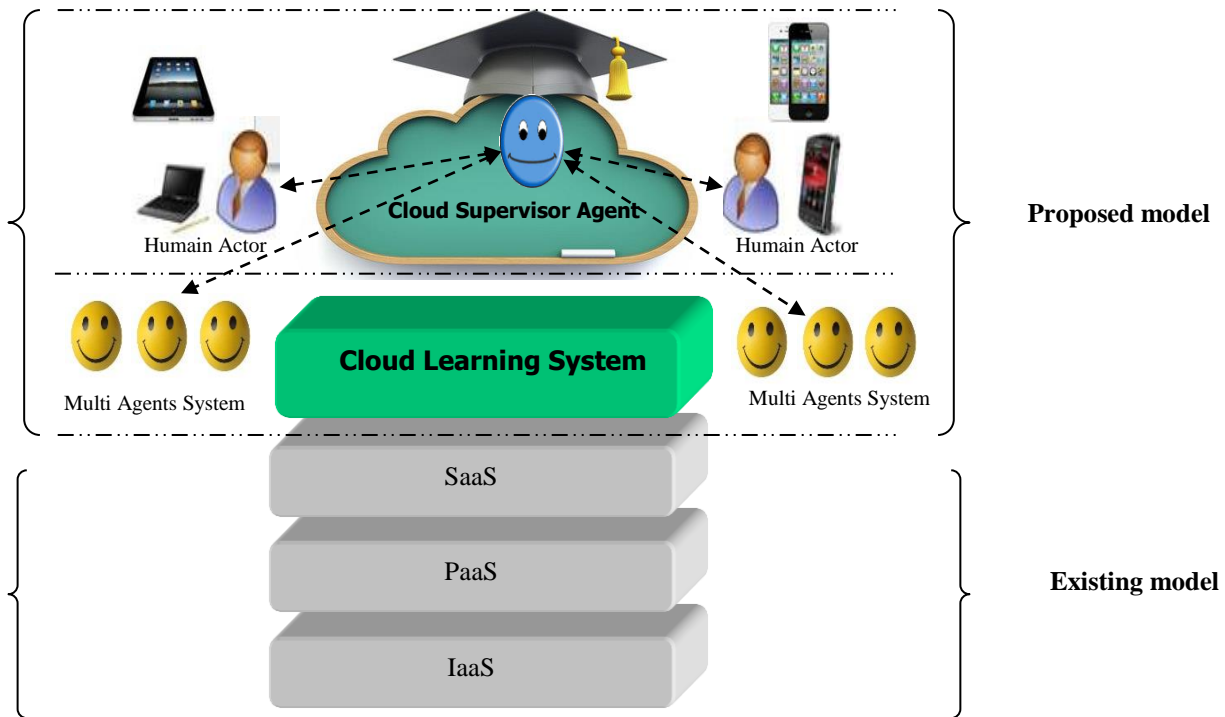- Facilitate the deployment of multi-agent system in the cloud.

Fig. 1. Smart Cloud Learning System Architecture

[1] http://www.claconnect.com/Risk-Management/The-Benefits-and-Risks-of-Cloud-Computing.aspx

Cloud infrastructures can offer an ideal platform where run Multi-agents system [8]. In fact, an agent is a software entity capable of acting intelligently on behalf of a user, in order to accomplish a given task. Agents, like humans, co-operate so that a society of agents can combine their efforts to achieve a desired goal [9]. The characteristic properties of the agents are:

- Autonomy

- Proactive intelligence (agents do not simply to act in response to their environment, but are able to take initiative)

- Temporal continuity (they are continuously running processes),

- Mobility,

- Rationality/benevolence (agents don't have conflicting goals)

- Adaptive intelligence (agents have the ability to learn).

Compared to objects, software agents have their own thread of control, localizing not only code and state but their invocations as well. In other words, agents themselves define when and how to act.

Agent-oriented methodologies and platforms have become a priority for the development of large scale agent-based systems. Several methodologies have been proposed for the development of multi-agent systems (MAS), they are either an extension of object-oriented methodologies (for example MaSE: Multi-agent System Engineering) [10] or an extension of knowledge-based methodologies (for example: CommonKADS) [11].

We have chosen the MaSE methodology (Multiagent System Engineering) for the development of our software agents. This choice is justified by:

- The simple, modest and pragmatic vision which MaSE gives to the definition of an agent

- The automation process for creating software agents

- The availability of documentation.

The systems based on agents specified starting from this methodology are often difficult to implement directly starting from the standard programming languages like Java or others. Several tools are developed recently for multi-agent systems programming: JADE [12], Zeus [13], MadKit [14], AgentBuilder [15]. For our part, after an evaluation of the most popular platforms of multi-agent systems development, we have chosen JADE (Java Agent Development Framework) which is a middleware that facilitates the development of multi-agent systems. It includes:

- A runtime environment where JADE agents can "live" and that must be active on a given host before one or more agents can be executed on that host.

- A library of classes that programmers have to/can use (directly or by specializing them) to develop their agents.

- A suite of graphical tools that allows administrating and monitoring the activity of running agents.

Basing on our model of a virtual campus [16] and on an approach centred on the roles and competences, we can specify and identify the agents which will build our Smart Cloud Learning System (Smart-CLS). This process is located in an iterative step of design whose results presented here are those after the most recent iteration. We present in "Fig. 2", an observer system of use for a given space in Smart Cloud Learning System.
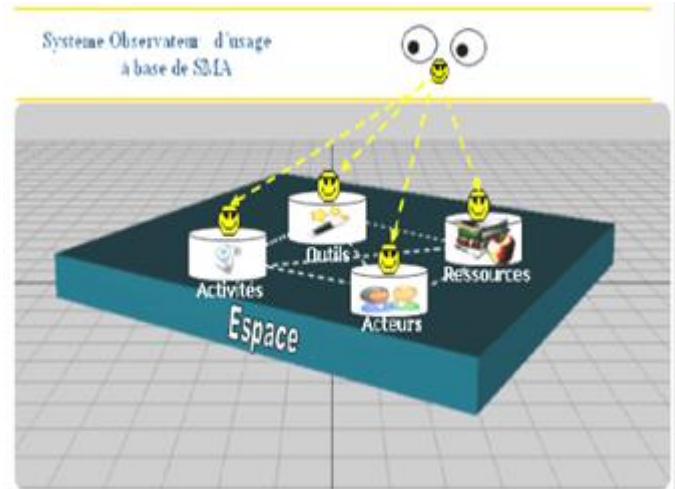

Fig. 1.   Smart -CLS observer system of use

The agent hierarchy of our Smart-CLS reporting system is made around several supervisory spaces agents. In occurrence public space, the group space, the team space and individual space. Each supervisory space agent communicates with four agents: the supervisory agent of the actors, the supervisory agent of the activities, the supervisory agent of the resources and finally the supervisory agent of the tools. Each one of these four agents can supervise other agents of lower hierarchy. For example, the supervisory agent of the tools can supervise the mail agent, the forum agent, the discussion agent, the document agent and the diary agent. Finally, a graphic user interface agent must ensure the communication with the user. We summarize here, the specifications of the agents constituting our reporting system in Smart-CLS:

- Graphical User Interface Agent (GUI Agent): its role is to ensure the human/machine communication trough a simple and convivial graphic interface.

- Supervisory Agent of space (public, group, team, individual): This agent is the access point to the space of which it is monitor. It answers the lower hierarchy agents for a reporting of a given period of use.

- Supervisory Agent of the actors: It supervises the whole of the actions carried out by an actor while providing a decision on its behaviour during a training session.

- Supervisory Agent of the activities: It indicates the degree of project respect and the level of activity success.

- Supervisory Agent of the tools: Its role is to provide statistics concerning the use of the tools with a relation of a given space.

- Supervisory Agent of the resources: It gives information on the use of the resources of a given space.

III. SMART CLOUD LEARNING SYSTEM: EXPERIMENTAL RESULTS

A. Context and Objective

Recent years have seen a growing recognition and general acceptance of the Project Based Learning (PBL) in education, especially in Moroccan higher education. This approach transforms teaching from "teachers telling" to "students doing" [17] [18] [19]. Students are facing several challenges during a project based learning session. The biggest challenge is: What methodology should be followed for successful project? In our laboratory, we propose to use the project management process such us a methodology that should be followed for successful project. In this context, we have conducted two experiments.

The objectives of these experiments are to understand the benefits of Smart-CLS in project management process and the feedback of students about it.

The first experiment has focused on a group of 69 undergraduate students in project based learning session without Smart-CLS during four weeks of May 2012 [20].

The second experiment has focused on a group of 109 undergraduate students in project based learning session with Smart-CLS, via a simple Web browser and an Internet connection, during four weeks of May 2014. Six Graphical User Interfaces agents (GUIs agents) of Smart-CLS have been used as avatar in order to facilitate the use of project management tools "Fig. 3"; namely:

- FA-Agent (Functional Analysis Agent), used to help students in Functional Analysis Phase

- FAST Agent (Functional Analysis System Technique Agent), which has a strict translation of each of the service functions in technical(s) function (s), then the constructively (s) solution (s)

- WBS Agent (Work Breakdown Structure Agent), which allows the cutting of the project task list

- RACI Agent (Realization, Approval, Consulting, Information Agent), which allows the definition of responsibilities.

- PERT Agent (Program Evaluation and Review Technique Agent) used to schedule, organize, and coordinate tasks within a project.

- GANTT Agent used for planning and scheduling projects.

Fig. 2. Smart-CLS with these GUIs agents

B. Result and discussion

At the first experiment, and as shown in figure 4, we have found a low percentage of use of project management tools. In fact, 34% of students have developed the functional analysis chart, only 20% have used the FAST diagram, 47% have broken the project into tasks WBS diagram, 24% have developed the RACI matrix, 19% have used the PERT diagram, 35% have used GANTT diagram for planning and scheduling projects.

In our sense, this result can be explained by the fact that the project management approach itself, consist of complex tasks that pose problems for students. Therefore, help and assistance is necessary. Hence the use of Smart –CLS.

At the second experiment,

- First, as shown in "Fig. 4", we observe a high percentage of use of project management tools. This result demonstrates the utility of Smart-CLS in this process. It is some of the most important applications of cloud computing in our University, with an aim to provide help and assistance as a modern ways of learning and teaching.

- Second, as shown in "Fig. 5", we note the type of devices used to access to Smart-CLS, in fact, 73% of students have used a laptop, 8% have used a desktop, only 2% have used a smartphone or tablet and 17% have accessed via an Internet cafe. However, with the increased availability of low-priced tablets and smartphones, it is expected that even more students would get an opportunity to get access to these tools over the next few years.
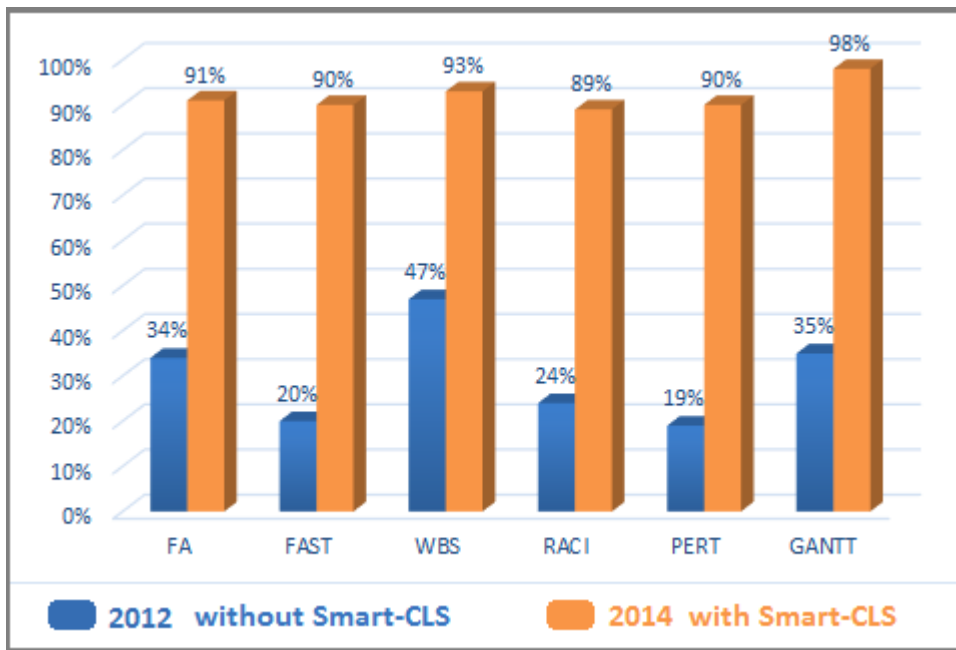
Fig. 3.   Statistic of project management tools used by students

- Third and as shown in "Fig. 6", we observe a high percentage of agent consultation rate, we find that the GUIs agents have been very consulted by students, in order to give them help and assistance; this can be explained by the difficulties encountered by students to implement the project management process.

- Finally, "Fig. 7" shows the results of a assessment questionnaire offered to students at the end of the

second experiment. The objective of this questionnaire was to evaluate the quality of help and assistance provided by GUIs Agent. Students are most satisfied with these agents. It is expected that even more students would get an opportunity to get access to these tools over the next few years, it is a great potential for innovation.
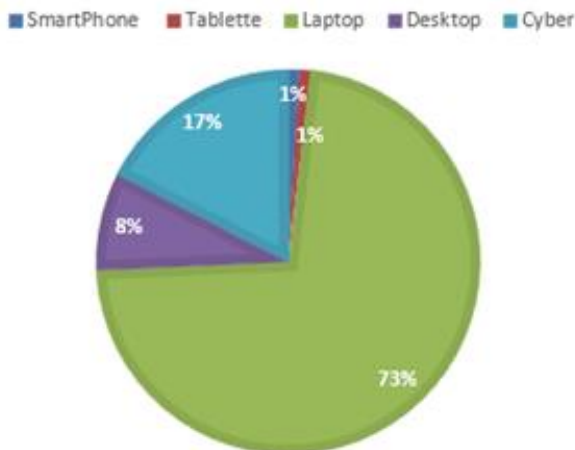

Fig. 4.   Devices used for access to Smart-CLS

Fig. 5.   Rate of GUIs Agent consultation by students

Fig. 6.   Quality of help and assistance provided by GUIs Agent

IV.   CONCLUSION & FUTURE WORK

We have demonstrated in this article that cloud computing can provide many benefits for university, and we have proposed an hybrid approach that combine the Cloud Computing and the Multi-Agents Technology to design a new layer called Smart Cloud Learning System.

Experimental results in a project management process context have validated the use of Smart-CLS and have demonstrated that it is some of the most important applications of cloud computing in our University, with an aim to provide help and assistance as a modern ways of learning and teaching. Students have been most satisfied.

The future work consists of experiment and validates Smart-CLS in Massive Open Online Courses (MOOCs). It is expected that even more students would get an opportunity to get access to these tools over the next few years, it is a great potential for innovation.

REFERENCES

[1] NIST, National Institute of Standards and Technology. 2013. " Cloud Computing Standards Roadmap Working Group", U. S. Department of Commerce, Reports on Computer Systems Technology, July 2013

[2] Whitepaper by Crucial Cloud Hosting, Cloud Computing in Education, March, 2014, available from http://www.crucial.com.au/pdf/Cloud_Computing_in_Education.pdf [Accessed 4th February 2015]

[3] Nungki Selviandro, Zainal Arifin Hasibuan. 2013. "Cloud-Based E-Learning: A Proposed Model and Benefits by Using E-Learning Based on Cloud Computing for Educational Institution", Springer Information and Communication Technology, Volume 7804, 2013, pp 192-201

[4] Md. Anwar Hossain Masud, Xiaodi Huang, "An E-learning System Architecture based on Cloud Computing," International Journal of Social and Human Sciences 04/2012; 6.

[5] E. Tuncay, "Effective use of Cloud computing in educational institutions, " Procedia Social Behavioral Sciences, p. 938–942, 2010.

[6] Y. Zhongze, "The basic principles of cloud computing and its impact on education", Satellite TV and Broadband Multimedia, 2010.6, pp.67-70.

[7] Z. Chengyun, "Cloud Security: The security risks of cloud computing, models and strategies", Programmer, May.2010, pp.71-73.

[8] Domenico Talia, "Cloud Computing and Software Agents: Towards Cloud Intelligent Services, " Proceedings of the 12th Workshop on Objects and Agents, Rende (CS), Italy, Jul 4-6, 2011, pp.2-6.

[9] Wooldridge Michael and Nick Jennings, "Intelligent Agents: Theory and Practice", Cambridge University Press , 1995.

[10] Arnon Sturm. 2005. "Multiagent Systems Engineering (MaSE) – An Introduction". 12-Jul-2005, available from http://www.pa.icar.cnr.it/cossentino/al3tf1/docs/mase4agentlink.pdf [Accessed 4th February 2015]

[11] C. e.a. Iglesias, "Analysis and design of multiagent systems using MAS-CommonKADS," in Proc. of AAAI'97, Workshop on Agent Theories, Architectures and languages, Providence, RI, 1997.

[12] Rimassa G., Bellifemine F., Poggi A, "JADE - A FIPA Compliant Agent Framework". PMAA`99, p. 97-108, Londres, Avril 1999.

[13] L. C. Lee, D. T. Ndumu, and H. S. Nwana , " ZEUS: An Advanced Tool-Kit for Engineering Distributed Multi-Agent Systems," in Proceedings of the Practical Application of Intelligent Agents and Multi-Agent Systems, p. 377-392, Londres,1998.

[14] O. Gutknecht, J.Ferber & F. Michel, RR, "MadKit: une plateforme multi-agent générique". Rapport interne, Laboratoire LIRMM, Université Montpellier II, Mai 2000

[15] AgentBuilder U.G.2004. An Integrated Toolkit for Constructing Intelligent Sofware Agents, AgentBuilder, User's Guide, Avril 2004, available from http://www.agentbuilder.com/Documentation/UsersGuide-v1.4.pdf [Accessed 4th February 2015]

[16] N. Elkamoun, M. Bousmah, Abdelhak Aqqal, A. Berraissoul. "Conception et réalisation d'un environnement virtuel d'apprentissage collaboratif, orienté métaphore spatiale, couplé avec un système observateur d'usage, " International electronic journal of the Information Technologies e-TI, vol. 2, no. 2, April 2006. ISSN 1114-8802

[17] M. Bousmah, N. Elkamoun, A. Berraissoul," Online Method and Environment for Elaborate the Project-Based Learning Specifications in Higher Education", Proceedings of the 6th IEEE International Conference on Advanced Learning Technologies, ICALT 2006, 5-7 July 2006, Kerkrade, The Netherlands. IEEE Computer Society 2006 BibTeX.

[18] Najib EL KAMOUN, Mohammed BOUSMAH, Abdelhak AQQAL. 2011. "Virtual Environment Online for the Project-Based Learning Session ", Cyber Journals: Multidisciplinary Journals in Science and Technology, Journal of Selected Areas in Software Engineering (JSSE), January Edition, 2011.

[19] Clifford F. Gray & Erik W. Larson. 2006. " Project Management the Managerial Process". (3rd ed.) McGraw Hill. pg. 6

[20] M. Bousmah, N. Elkamoun. 2014. " Feedback of Project Management Approach in Higher Education Science" 26th Symposium of the European ADMEE 15-16-17 January 2014 in Marrakech, Morocco.