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Application of Cloud and Fog Computing in Educational Process upon Implementation of Master's Degree Program

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Abstract*: *This article discusses a variant of application of cloud and fog computing for training process upon implementation of educational programs on the basis of e-learning courses (ELC) aiming at replacement of conventional courses presented by human teachers by courses based on innovative technologies. The arguments are adduced that application of cloud services and fog nodes upon the use of ELC in training process provides wider possibilities for delivery of educational content in comparison with conventional learning. Solutions are proposed capable to expand application of approaches to the use of cloud and fog computing in educational process.

Index Terms: training process, cloud computing, fog computing, server cluster, private cloud, educational service, hybrid architecture.

I. INTRODUCTION

Cloud and fog computing came into our life as a consequence of efficiency improvement of application of accumulated global computing capacities by expansion of user community and by delivering them certain computing services in user convenient form. Consumers of cloud and fog computing can reduce significantly expenses for infrastructure of information technologies (on short term and medium term basis) and response flexibly to modifications of computing demands using flexibility of cloud services and fog computing which continue conventional cloud computing model.

II. METHODS

Obvious advantages of cloud computing in comparison with conventional approaches to computer aids quite naturally raise the issue of reasonability of application of this technique including training process. In this case the cloud computing is considered in terms of arrangement of cooperation among manager of educational program, teachers, and students with regard to implementation of these programs aiming at achievement of general results, that is, successful assimilation of proposed information and acquisition of knowledge, skills and habits, providing them possibility to get excellent mark after intermediate examination in a discipline and final attestation in overall educational program.

In order to use cloud, it is required to be aware of its purpose and to be able to apply this knowledge in practice. Nowadays in educational process, mainly upon determination of the cloud purpose, the main selected issues are usually decrease in total expenses and types of cloud solutions aimed at the use of contacts, maintenance of processes and data storage. From the authors' perspective, cloud is, first of all, an innovative efficient tool for arrangement of training process on the basis of delivery of educational content via ELC from these, who possess the content, to those who need it, thus arranging certain platform for cooperation between them [1].

III. RESULTS

While using cloud in training process, the authors aimed at conversion of cloud into an efficient tool of delivery of training content and knowledge from teachers to students during implementation of educational program. This target was implemented on the basis of "Initial model of implementation of educational program" (Fig. 1).

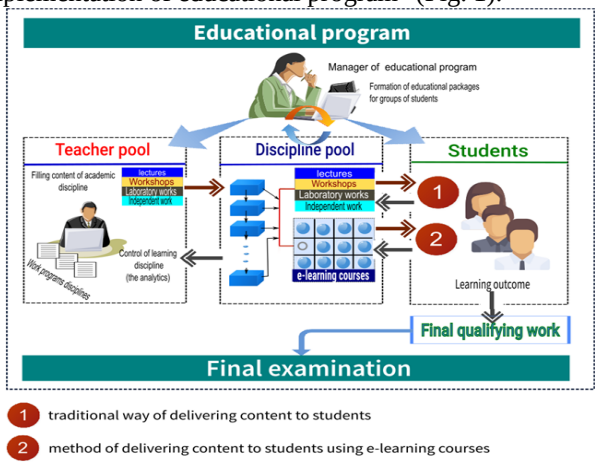

Fig. 1. Initial model of implementation of educational program.

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The model is comprised of the following components playing quite definite and important role in educational process:

a) Manager of educational program;

b) Teacher pool participating in implementation of certain educational program;

c) Discipline pool including overall set of basic, varied and other training disciplines in educational program delivered to students both by conventional method (in the form of lectures, practical classes and so on using classrooms) and by the proposed method in the form of e-learning courses (ELC);

d) Students who acquire knowledge both by conventional method (marked as "1") and using data base of ELC (marked as "2") [2].

Final target is graduation thesis and final examination of students.

In order to implement practically the proposed model, a hybrid architecture was developed for delivery of educational content packages and fog node which implemented interactions among participants of training process. The integer architecture with single fog node is illustrated in Fig. 2.

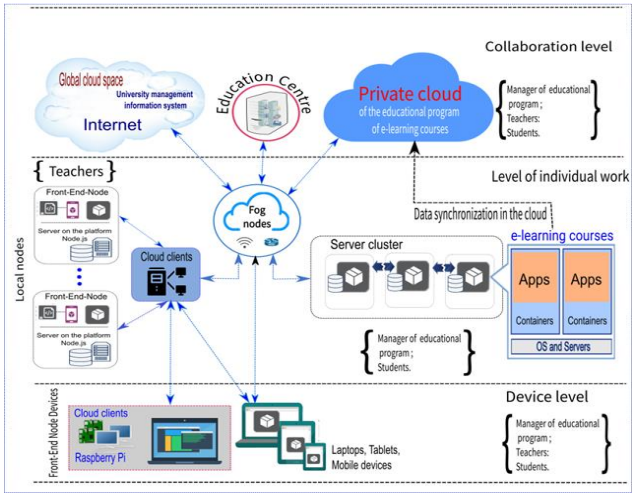

Fig. 2. Hybrid architecture of the most suitable provision of education content-packages upon implementation of educational programs.

This architecture reflects all required components of implementation of educational program (Fig. 1). The hybrid architecture makes it possible to apply fog computing for optimization of load distribution on cloud infrastructure and to provide feasibility of applications while using innovative method of delivery of educational content packages to students and without limitations to users of cloud services.

In terms of the used components the presented architecture is subdivided into three levels [3].

The first level includes components of shared usage, including private cloud of educational program which is used for provision of shared operation for all participants of training process by means of special services. Since the private cloud requires administration, this function is performed by the manager of educational program (administrator of the 1st level of educational program).

The second level is the level of individual work. This level includes the components providing interaction between the users (the manager of educational program, teachers, and students) via API REST directly with ELC without necessity to use cloud. Development and administration of ELC for a single discipline is performed by a teacher (administrator of the 2nd level of educational program) via local nodes (Front-End-Node).

Interaction of local nodes, Node-to-Node, with other components is carried out by means of the component: cloud clients. Verification of ELC for conformity with discipline working programs and subsequent placement of ELC in application containers on server cluster is carried out by manager of educational program.

Application of fog node is stipulated by the necessity to reduce data amount transferred to the cloud, which decreases requirements to network capability, increases data processing rate, and reduces delays in solution adoption.

The third level is the level of access from terminals and user devices to cloud services and ELC applications. Communication type: Node-to-Cloud.

The subdivision into three levels is stipulated also by the fact that, as shown in practice, while using the proposed solution in training process, teachers and students most often approach directly to the ELC applications without cloud bursting. And since the educational content implemented by ELC according to requests from teachers and students is mainly static and requests to cloud services are dynamic (the main purpose of the cloud), then in this architecture (Fig. 2) it was proposed to redirect the static requests to scalable server cluster arranged by software.

Cluster hardware used at present is comprised of HP 260 minicomputer (500 Gb HDD), where common data of the cluster are stored together with backup system, and Raspberry Pi2/3 single board computer with ELC. While entering data via ELC applications, synchronization is performed with cloud storage. Technical implementation of the proposed solution with fog node of delivery of educational content packages upon implementation of educational programs is illustrated in Fig. 3.

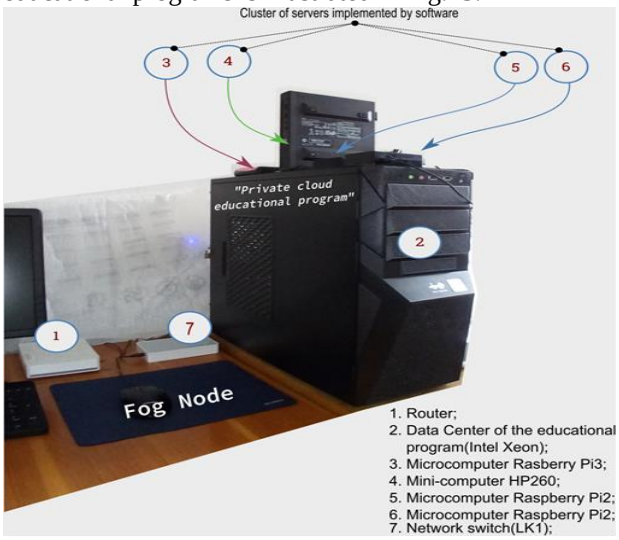

Fig. 3. Technical implementation of hybrid architecture.

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As a consequence of the presented solution, the following advantages have been revealed in comparison with the conventional approach to training process:

• it is possible to replace the courses delivered by human teachers with the courses based on innovative technologies at significantly reduced cost;

• the teachers are transformed into narrators of obligatory content and assistances of students answering their questions and helping them when necessary;

• it is possible to improve continuity, quality and spread of knowledge, to prepare students for creative activity in the changing world under the influence of new IT;

• high flexibility upon access to the content of educational discipline and outer sources of information;

• extended possibilities of mutual work in small sized groups while carrying out laboratory, course, and independent works;

• application of advanced techniques of arrangement of training process which simplify (support) assimilation of educational content and acquisition of required skills;

• educational content on various platforms or versions of cloud using fog nodes in physical embodiment, depending on sets of hard- and software, their configuration, computing capacity and other specifications.

IV. DISCUSSION

At present in the frames of the presented solution the authors focused attempts on the issue of development and presentation of personalized content and formation of educational packages for students with various level of training by means of inclusion of operative analytics into ELC. This would permit with sufficient accuracy to trace which educational video content was studied by each student, which assignments and tests were passed successfully, which topics should be repeated, because the embedded would reveal difficulties related not only with specific assignment but assimilation of overall educational discipline.

The proposed solution makes it possible to provide in fact instant response to occurring difficulties during the training course, to provide high quality consultations for students, and to decrease expenses for administration: participants in the educational program independently develop, maintain and monitor their own resources. For instance, course papers are performed directly in cloud. Herewith, teacher receives service notifications about the progress of the works in real time and, if necessary, renders online consultations to students. Course papers are presented directly in cloud using ELC services.

V. CONCLUSION

Implementation of the described solutions makes it possible to involve students into the development process of services. This is especially important upon training of masters since such approach provides additional possibility to improve their skill level and, as a consequence, to obtain deeper knowledge and practical experience in the selected field of study.

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