UDC 004.75:37

A.V. TOLBATOV, S.V. AGADZHANOVA, O.B. VIUNENKO
Sumy National Agrarian University, Sumy
V.A. TOLBATOV
Sumy State University, Sumy

USING BLOCKCHAIN TECHNOLOGY FOR E-LEARNING

Annotation. This article introduces the main principles of the Blockchain focusing on its potential for the e-learning. It explains how this technology may both disrupt institutional norms and empower learners. It proposes one of scenarios for the application of the Blockchain in an education context, based on the current state of technology development and deployment.

Blockchain is a modern information technology, providing creation of growing lists of data sequences. A separate parts of the chain are called «blocks, which are linked using cryptography. Each component of the system remembers the previous one, unauthorized changes are immediately blocked. The blockchain works as a decentralized register that stores data on the Internet with an open access to the public.

Blockchain can be implemented within the automated management systems of individual higher education institutions or groups of educational institutions. Each user who wants to store his personal and financial data as safe as possible, and to provide a reliable information on his qualifications, can use blockchain technologies.

The most upcoming areas to implement multi-agent systems in e-learning are: personalization, i.e. adaptation of the website content and design, allowing you to easily move from the standard website form and a set of individual tasks to a view that takes into account the features of each individual student; identification of the user session; each user during the working period can visit the university ACU many times and with different purposes, therefore, user visits must be divided into separate sessions; creation of temporary working groups of students; creation of a competitive environment and support of the rating system; verification and analysis of professional skills in case of further corporate training. It should be noted that Blockchain technology can serve as a basis for implementing a centralized but actually distributed national database for authentication and certification.

Key words: Blockchain, information system, information technology, e-learning, automated management systems.

А.В. ТОЛБАТОВ, С.В. АГАДЖАНОВА, О.Б. В'ЮНЕНКО
Сумський національний аграрний університет, м. Суми
В.А. ТОЛБАТОВ
Сумський державний університет, м. Суми

ВИКОРИСТАННЯ ТЕХНОЛОГІЇ BLOCKCHAIN ДЛЯ E-LEARNING

Анотація. Стаття містить основні принципи технології Blockchain, зосереджуючи свою увагу на її можливостях для електронного навчання. Проведено аналіз сценаріїв для застосування Blockchain в контексті освіти, виходячи з сучасного стану технологій.

Ключові слова: Блокчейн, інформаційна система, інформаційні технології, електронне навчання, автоматизовані системи управління.

INTRODUCTION. E-learning is considered now to be a flexible tool for student training. It is developing dynamically and is focused on mobile learning, micro learning, automation of learning processes, working with large volumes of data, video tutorial, gamification, personalized learning, cloud technology and transition from distance learning systems to knowledge management systems. Therefore, we deal with the increasing relevance of the content, forms, control and other activities of e-learning, as well as protection of personal data of the user's academic achievements in the university database with the help of the latest information technologies, namely, Blockchain technology [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16].

Objectives: summarizing the experience and developing recommendations on the possibilities of implementing and using Blockchain technology in e-learning systems.

MAIN POINTS. Blockchain is a modern information technology, providing creation of growing lists of data sequences. A separate parts of the chain are called «blocks, which are linked using cryptography. Each component of the system remembers the previous one, unauthorized changes are immediately blocked. The blockchain works as a decentralized register that stores data on the Internet with an open access to the public.

Not a single centralized server, but the computer power of all participants of the process are used to create a cryptography. It means that any user of the system built on the blockchain can also be its owner.

This approach offers the following benefits: a decentralized recording method by means of cryptography, mathematical algorithms and time that provides:

- transparency of operations;
- inability to falsify information and enter new records, not following the established rules;
- information security, high protection against unauthorised access, information destruction or modification;
- high speed of operations;
- low processing costs.

Decentralized access disables or minimizes the possibility of unauthorized access to the system aimed on entering false data. It saves the resources of universities, since it does not require additional costs to ensure data

verification and storage. It also reduces the influence of the human factor as well as the errors from the computer side.

Usage of decentralized technologies is planned and has already been partially implemented at the state level: e-Auction 3.0, e-Vox, E-Ukraine.

Blockchain technology is ideal as a new infrastructure to secure, share, and verify learning achievements.

The centralized model of present-day learning is no longer sustainable – indeed, blockchain technology allows a total disintermediation and disaggregation of higher education. Today, learning happens increasingly outside the brick-and-mortar lecture hall universities: it happens on online platforms, within communities of like-minded individuals, or by contributing to projects and initiatives in the real world. Blockchain technology may hold the answer to securely and verifiably collating the outcomes of this new distributed learning reality." Students gain control and ownership of all their education data, their accreditation and portfolios of work, in a secure place that is accessible to anyone who needs to verify them – and for their entire lifetime. Within a context where students, teachers and course authors are in a direct relationship with one another, new transactional models will emerge. For example, when a student views a learning video, a small micropayment can automatically be made to the video authors [1 – 10].

Within this emerging model, micro-accreditation will take place through a blockchain. Transferability of skills could also be facilitated through the accreditation of MOOCs – again, the future seems to indicate mix and match teaching and learning via different media and different locations for face to face learning. There are also significant opportunities in those areas which are increasingly positioned as alternatives (or in opposition to) mainstream academic approaches, such as VET, corporate training and the qualifications awarded by professional bodies, such as those in finance.

Thus, for example, a student may be awarded a certificate attesting a degree only if it has been issued for an accredited program, which was in turn issued by an accredited university, which in turn was accredited by an accredited quality assurance agency.

Introduction of intelligent e-learning interfaces based on blockchain technology.

The characteristic features of multimodal intelligent interfaces, which implementation ensures a natural user-machine interaction, are considered in [9, 16]. The implementation of these features depends on the particular system, where the appropriate interface is required. Implementing any feature of the interface involves clear specification, as well as the ability to formally verify this specification applied to the interface of a certain system. In general, they distinguish the following properties of intelligent agents: 1) activity, i.e. the ability to generate intermediate goals and act rationally to achieve them; 2) independence, i.e. the ability to work without its owners interference and to control the internal state; 3) basic knowledge, i.e. the agents knowledge about itself, the environment, other agents that do not change during the agent's operation; 4) social behavior, i.e. the ability to interact with other agents; 5) desires, i.e. states or situations, the achievement of which is critical for the agent; 6) obligations, i.e. tasks that the agent assumes when it is accessed by other agents; 7) "beliefs", i.e. a variable part of the basic knowledge that can change in time, the agent may not know about and continue to use them; 8) goals - a set of conditions, the current behavior of the agent is directed to; 9) reactivity is an adequate perception of the environment and reaction to its changes;

It is rather challenging to obtain the reliable information on the Internet due to the huge amount of available data. For now, the widely used search tools fail to provide high-quality search. The most advanced search capabilities are provided today by the keyword search systems. The main disadvantage of such systems is poor accuracy of the information provided.

Improving the capabilities of such systems, aimed at increasing the accuracy of information, leads to the complication of their query language. In addition, each system has its own syntax for query language. As a result, this results in the user having to process a large number of documents himself.

That is why an important step is to select the prediction methods of user action. They in turn include: sample search, cognitive modeling, applying the libraries of actions, and errors, shell systems and model logic.

All together intelligent agent is a hardware or software entity that can act independently in order to achieve the goal set by the owner or user. Multi-agent systems are a kind of agency, a software and computing complex, where various agents interact to solve the task assigned to them. At the same time, an intelligent agent can be viewed as a cognitive system that has the ability to act after a decision has been made.

The main feature of the cognitive agent (Figure 1) is that it receives information from three sources: 1) from the user in the form of goals and current instructions; 2) from the system itself; 3) from its own knowledge base. Integration of these information processes is a necessary condition for management.

Ambient intelligence technology is a promising interdisciplinary technology formed at the junction of cybernetics, artificial intelligence, computer technology and cognitive sciences. The term "Ambient Intelligence" means an extended physical environment with technical devices sensitive to people's actions that in turn involves recognizing users, understanding their goals and context, predicting behavior.

Modeling of multi-agent models in ambient intelligence environments involves: 1) strategic multi-agent modeling in a specific environment; 2) modeling of dialogues and negotiations between cognitive agents; 3) modeling of group training of agents in intellectual environments; 4) transition from the groups of agents to artificial ecosystems; 5) development of mobile agent technology. Thus, a significant part of the information space of the ambient intelligence environment is formed by the intelligent agents. The interaction of these agents while

processing information can significantly reduce the requirements to their computing resources and increase the validity of the results. In general, the concept of AmI is closely related to the Service Science, because it is aimed on providing certain services to users. A service-oriented architecture can also be used when implementing interactions between agents, i.e. services that they can provide to other agents. Thus, modern systems of e-learning and certification should be considered as a community of intelligent agents.

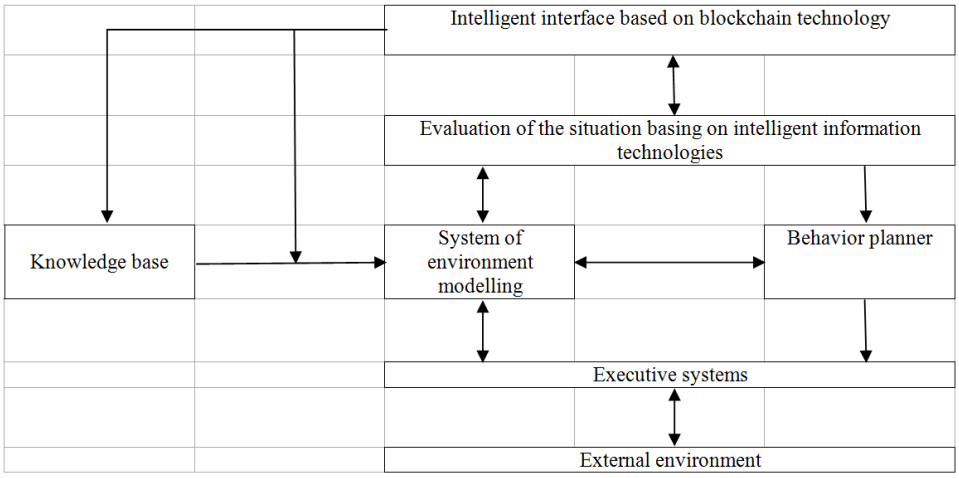

Fig. 1. Architecture of the intelligent cognitive agent

Blockchain can be implemented within the automated management systems of individual higher education institutions or groups of educational institutions. Each user who wants to store his personal and financial data as safe as possible, and to provide a reliable information on his qualifications, can use blockchain technologies.

The process of registering and using such a system by the end user is quite simple. It consists of the following steps:

1. Download the necessary software from the university website. After running the file on the computer (smartphone), install a package consisting of two programs known as i-ASU and i-ASUCert.
2. Order a New Certificate by means of i-ASUCert:
   - firstly, you have to confirm that you want to get a certificate;
   - then you specify the personal data using which you apply for certificate;
   - the system proposes to protect your certificate with a password;
   - at the next step you may need to select required certificate type, if you plan to place data on several e-learning systems;
   - request is stored on your computer as a x.pp1 file.
3. The request, a x.pq1 file, is posted on the website of the university. If you have any problems, you will immediately see it.
4. Having received a confirmation of the request, the user must send a certified copy of his documents by mail, as well as a document certifying the identity.
5. After receiving copies, your personal "certificate" will be sent to your email address as a x.pq2 file. You will also receive a conditional name and password that will allow you to later access the information about your resources on the corresponding website.
6. Having received the certificate, the user must import it into the i-ASUCert program.
7. After the file is imported, the user can proceed to the digital "signing" of his information.
8. When story in one of these formats is ready and verified, the user can work with the university ASU.
9. When the system receives all the necessary information, it begins to process ("sign") the client data. The process is rather slow (about 20 minutes).
10. The client part of the program is linked to the user's hardware, so another key x.pq3 file is automatically generated to switch to another computer.

It should be noted [15, 16] that this approach allows using intelligent agents of various types and complexity levels. It provides an opportunity to model the approaches to the distribution of sub-tasks between agents and to organize a correct interaction between agents in this case. The cases of cooperation and conflicts between agents of various e-learning systems were also reviewed. The organization of interface by means of an intelligent agent involves creating an entity that owns all the information about the system (knowledge of the system business logic, access to the knowledge base). Such an entity can potentially respond to any query regarding the system and the knowledge that it contains.

CONCLUSION. The most upcoming areas to implement multi-agent systems in e-learning are:

- personalization, i.e. adaptation of the website content and design, allowing you to easily move from the standard website form and a set of individual tasks to a view that takes into account the features of each individual student;

- identification of the user session; each user during the working period can visit the university ACU many times and with different purposes, therefore, user visits must be divided into separate sessions;
- creation of temporary working groups of students;
- creation of a competitive environment and support of the rating system;
- verification and analysis of professional skills in case of further corporate training.

In conclusion, it should be noted that Blockchain technology can serve as a basis for implementing a centralized but actually distributed national database for authentication and certification.

Literature

[1] Agadzhanova S. Information technologies in the educational process as the basis of modern distance learning / O. Viunenko, A. Tolbatov, S. Vyganyaylo, V. Tolbatov, S. Agadzhanova, S. Tolbatov // TCSET 2016 – Lviv-Slavske, 2016. – P. 831–833.

[2] Tolbatov A. Data Representing and Processing in Expert Information System of Professional Activity Analysis / O. Zaritskiy, P. Pavlenko, A. Tolbatov // TCSET 2016 – Lviv-Slavske, 2016. – P. 718–720.

[3] Agadzhanova S. Dosvid vprovadzhennya tekhnolohiy dystantsiynoho navchannya u vyshchyy ahrarniy shkoli / A.V. Tolbatov, V.A.Tolbatov, S.V. Ahadzhanova, K.Kh. Ahadzhanov-Honsales, N.L. Barchenko, O.Y. Zorenko, V.H. Lohvinenko, S.V. Tolbatov / Odesa: KUPRYENKO SV, 2015. – S.45-59.

[4] Tolbatov A.V. Modern technologies of distance learning in agrarian higher school / S.V. Ahadzhanova, K.H. Ahadzhanov-Gonsales, A.V. Tolbatov, O.I. Zorenko, V.H. Lohvinenko, N.L. Barchenko, V.A. Tolbatov, S.V. Tolbatov // SW Journal Pedagogy, Psychology and Sociology. – Volume J21508 (9). (November 2015). – P. 109-114.

[5] Tolbatov A.V. Vykorystannya personal'nykh navchal'nykh seredovyshch dlya orhanizatsiyi dystantsiynoyi formy navchannya / A.V. Tolbatov, O.B. V‘yunenko // (IMA :: 2016) : materialy ta prohrama NTK, 18–22 kvitnya 2016 r. – Sumy : SumDU, 2016. – S. 159.

[6] Modelyuvannya v osviti: Stan. Problemy. Perspektyvy / Za zah.red. Solovyova V.M. - Cherkasy: Brama, vydavets' Vovchok O.Yu., 2017. - 266 s.

[7] Tolbatov A.V. Development and support of the intelligent system of distance education in universities. / A.V.Tolbatov, V.A. Tolbatov, S.V Tolbatov, D.I. Chechetov // Modern scientific research and their practical application. – Volume J11410. May 2014 – P. 101-105.

[8] Tolbatov A. Mathematical models for the distribution of functions between the operators of the computer-integrated flexible manufacturing systems / E. Lavrov, N. Pasko, A. Krybidub, A. Tolbatov // Proceedings of the XIIIth International Scientific Conference TCSET’2016, 2016. – P. 72–75.

[9] Tolbatov A. Development of adaptation technologies to man-operator in distributed E-learning systems / Lavrov, E., Pasko, N., Barchenko, N., Tolbatov, A. / 2017 2nd International Conference on Advanced Information and Communication Technologies, AICT 2017 – Proceedings – Lviv, 2017. – P. 88–91.

[10] Tolbatov A. Cybersecurity of distributed information systems. The minimization of damage caused by errors of operators during group activity / Lavrov, E., Tolbatov, A., Pasko, N., Tolbatov, V. / 2017 2nd International Conference on Advanced Information and Communication Technologies, AICT 2017 – Proceedings – Lviv, 2017. – P. 83–87.

[11] Tolbatov A. Using cloud technologies based on intelligent agent-managers to build personal academic environments in E-learning system / Agadzhanova, S., Tolbatov, A., Viunenko, O., Tolbatova, O. / 2017 2nd International Conference on Advanced Information and Communication Technologies, AICT 2017 – Proceedings – Lviv, 2017. – P. 92–96.

[12] Tolbatov A. Theoretical bases, methods and technologies of development of the professional activity analytical estimation intellectual systems / Zaritskry O., Pavlenko P., Sudic V., Tolbatov A., Tolbatova O., Tolbatov V., Viunenko O. / 2017 2nd International Conference on Advanced Information and Communication Technologies, AICT 2017 – Proceedings – Lviv, 2017.–P. 101–104.

[13] Tolbatov A.V. Information technology for data exchange between production purpose integrated automated systems / P.M. Pavlenko, A.V. Tolbatov, V.V. Tretiak, S.V. Tolbatov, V.A. Tolbatov, O.B. Viunetko // Magazine Measuring and computing devicesin technological processes. – Khmel'nyts'kyy, 2016. – №1 –P.86–89.

[14] Tolbatov A.V. Functional modeling – methodological basis for invertigation of business processes at indusrtial enterprises / A.V. Tolbatov, S.V. Tolbatov, O.O. Tolbatova, V.A. Tolbatov // Magazine Measuring and computing devicesin technological processes. – Khmel'nyts'kyy, 2017. – №3 –P.186–189.

[15] Tolbatov A.V. Xmarni texnologiyi yak osnova formuvannya yedy`nogo informacijnogo seredovy`shha vy`shhogo navchal`nogo zakladu /O.B. V'yunenko, A.V. Tolbatov, V.A. Tolbatov // Vy`miryuval`na ta obchy`slyuval`na texnika v texnologichny`x procesax. – Xmel`ny`cz`ky`j, 2016. – №2 –S.90–96.

[16] Tolbatov A.V. Modelyuvannya v osviti: Stan. Problemy. Perspektyvy: Aktual'ni pytannya pobudovy systemy monitorynhu dystantsiynoyi osvity ahrarnykh VNZ / Za zah.red. Solovyova V.M.–Cherkasy: Brama, vydavets' Vovchok O.Yu., 2017.–266 s.

Рецензія/Peer review : 9.1.2018 р. Надрукована/Printed :9.4.2018 р.
Рецензент :