



Mining Education: Traditions and Perspectives in the 21st Century

UDC 378

APPLICATION OF ELECTRONIC LEARNING TOOLS FOR TRAINING OF SPECIALISTS IN THE FIELD OF INFORMATION TECHNOLOGIES FOR ENTERPRISES OF MINERAL RESOURCES SECTOR

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The article shows the advantages of using modern electronic learning tools in the training of specialists for the mineral and raw materials complex and considers the basic principles of organizing training using these tools. The experience of using electronic learning tools using foreign teaching materials and involving foreign professors is described. A special attention is given to the electronic learning environment of the Cisco Networking Academy – Cisco NetAcad. The experience of teaching at the Networking Academy of the Saint-Petersburg Mining University is described. Details are given to modern virtual environments for laboratory work, such as Cisco Packet Tracer, GNS3 and Emulated Virtual Environment. The experience of using electronic learning technologies at the University of Economics of Bratislava is considered. It actively cooperates with a number of universities of other countries, such as the University of International Business (Almaty), the Eurasian National University named after LN Gumilyov (Astana) and the Institute of Social and Humanitarian Knowledge (Kazan).

Key words: electronic learning, unified communications, international cooperation in education, Cisco Networking Academy

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The development of international cooperation in the sphere of education implies the active involvement of leading professors from foreign universities and the use of world-class teaching materials developed and used abroad. However, the long-term presence of a foreign professor at a university is not always possible for teaching a full course both for economic reasons and because the teacher can not leave his university for a long time. The solution of this problem becomes possible with the use of modern means of electronic learning tools and information and communication technologies [6].

As an electronic learning tool, LMS systems such as Moodle and Canvas are currently used. Teaching materials for these systems are prepared by both qualified teachers and entire companies, for example, Cisco Systems Corporation. To organize a live communication between the professor and students, various video conferencing and web-conferencing systems are used. For example, in the Mining University for several years, there has been conducted research and development activities for working out its own unified communications systems. Particularly, in [4] a system for organizing Internet conferences is described, and in [5] – methods for solving some problems that arose during its development. In the Mining University, the research on the use of speech recognition technologies in teaching foreign languages [9] has also been conducted.

The interactive learning environment Cisco NetAcad, based on LMS Canvas, includes the best cloud applications and is created on the basis of the latest trends and advanced techniques in electronic learning [1]. The system includes a number of constantly updated courses from Cisco, such as «IT Essentials», «CCNA Routing and Switching», and «CCNA Security», as well as a number of courses from other companies, such as C ++ Institute's «Programming Essentials in C ++» and «Linux Essentials» from NDG (Fig. 1).

Training materials, laboratory works and exam questions are presented in English, Russian and other languages. All materials are available for free through the Internet for teachers and students of the Academy. Administration of current, transfer and final examinations is carried out in a test form with the help of the exam server of the Academy.



Other training courses

Choose academy/educational institution

Saint-Petersburg Mining University -CA

Currently you can teach the following courses

- ✓ IT Essentials: PC Hardware and Software
- ✓ CCNA R&S: Introduction to Networks
- ✓ CCNA R&S: Routing and Switching Essentials
- ✓ CCNA R&S: Scaling Networks
- ✓ CCNA R&S: Connecting Networks
- ✓ CCNA R&S 6.0 Bridging
- ✓ CCNA Discovery 1: Networking for Home and Small Business
- ✓ CCNA Discovery 2: Working at a Small-to-Medium Business or ISP
- ✓ CCNA Discovery 3: Introducing Routing and Switching in the Enterprise
- ✓ CCNA Discovery 4: Designing and Supporting Computer Networks
- ✓ CCNA Exploration 1: Network Fundamentals
- ✓ CCNA Exploration 2: Routing Protocols and Concepts
- ✓ CCNA Exploration 3: LAN Switching and Wireless
- ✓ CCNA Exploration 4: Accessing the WAN
- ✓ CCNA Security
- ✓ CCNP ROUTE: Implementing IP Routing
- ✓ Networking Essentials
- ✓ Introduction to the Internet of Everything
- ✓ Introduction to IoT
- ✓ IoT Fundamentals: Hackathon Playbook
- ✓ Entrepreneurship
- ✓ Introduction to Cybersecurity
- ✓ Cybersecurity Essentials
- ✓ Get Connected
- ✓ Be Your Own Boss
- ✓ Packet Tracer Know How 1: Packet Tracer 101
- ✓ Packet Tracer Know How 2: Packet Tracer Mobile
- ✓ Mobility Fundamentals
- ✓ Community: Smart Grid Essentials
- ✓ Partner: NDG Linux Essentials
- ✓ Partner: NDG Linux I
- ✓ Partner: NDG Linux II
- ✓ Partner: CPA - Programming Essentials in C++
- ✓ Partner: CLA - Programming Essentials in C

Fig.1. Courses taught in Networking Academy
of the Mining University

To organize the training on the site of the Cisco Networking Academy, one needs to create a classroom, in which all the students of the group are registered. At the same time, they get access to the electronic textbook, laboratory works and examination system.

An electronic textbook for each course consists of several chapters. Each chapter ends with conclusions and tests. The textbook interface has a convenient navigation system, search and bookmarks. All material is provided with high-quality illustrations, videos and interactive tasks.

To conduct laboratory work, Cisco's network equipment and various virtual environments are used, and there are many of them in the system [8, 10]. All virtual environments can be divided into simulators and emulators of real equipment [2]. Simulation frames include software products that imitate the operation of real equipment by performing a predetermined set of instructions. In this case, it is only necessary to go beyond this frame, as the work of the simulator is immediately violated. Emulators are used when running firmware for real network devices. They can also have some limitations, but they are much less than in case of simulators.

To carry out laboratory work in a virtual environment, Cisco offers a Cisco Packet Tracer (PT) simulator that complements real network equipment. There are other virtual environments for laboratory work, such as the Boson Netsim simulators and the Enterprise Network Simulation Platform (eNSP), the GNS3 emulators, the Cisco Cloud Service Router (CSR), the Cisco Nexus Titanium, the Virtual Internet Routing Lab (VIRL), Unified Networking Lab (UNetLab, UNL) and its further development – Emulated Virtual Environment (EVE).

Cisco Packet Tracer is a multifunctional network modeling program that allows students to experiment with network behavior and evaluate possible scenarios. Being an integral part of the networked learning environment of the Networking Academy, PT provides the functions of modeling, visualization, testing knowledge and developing new laboratory work. PT is available free of charge to instructors, students and graduates of the Academy, and from version 6.3 for everyone who wants to get the access to these materials. There are versions for Microsoft Windows, Linux, Google Android and Apple iOS.

The laboratory work carried out in the PT environment contains a varied set of tasks and instructions, an automatic accounting system for correct actions and execution time timer. Before the start of the task, each student must fill in the user profile, when the change is made, the success count is reset to zero. This allows you to achieve the performance of laboratory work by each student as individually as possible, and time to check laboratory work is minimized.

Among the advantages of PT there are the ease of installation and user-friendliness of the interface. In addition, it has a convenient implementation of the functions for studying various network services, such as DHCP, DNS, HTTP, SMTP, POP3, NTP and many others. It is possible to go into

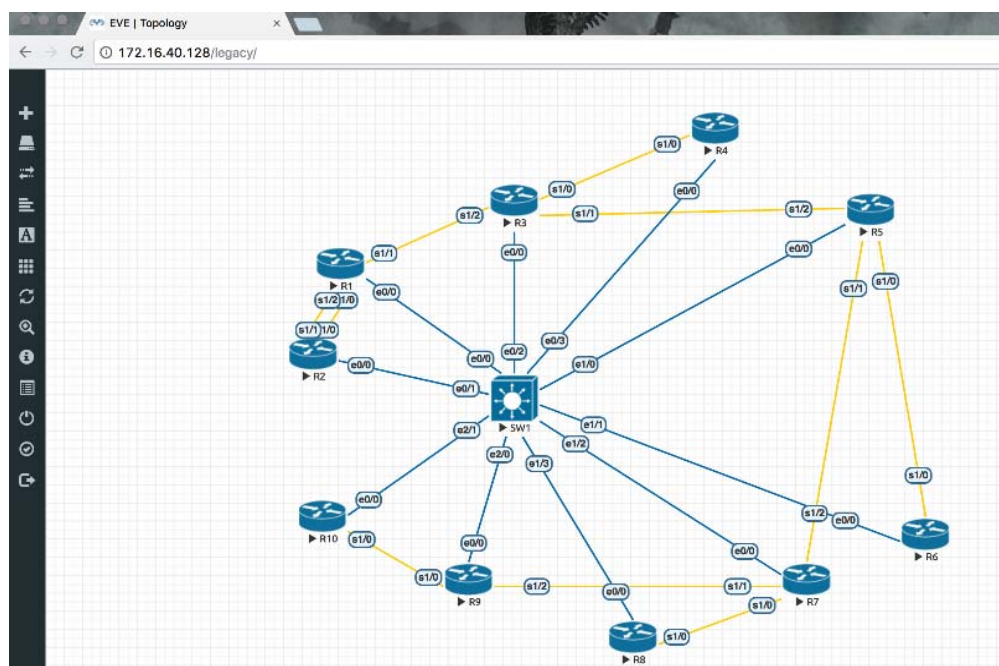


Fig.2. Network model layout, opened in EVE

Simulation mode and see in a slow-motion mode the transfer of packets between devices. A distinctive feature is the display of the physical appearance of devices with the ability to add or remove their individual elements and expansion modules, and in recent versions the user can simulate the operation of wireless networks Wi-Fi and 3G/4G. The drawbacks include the limitations of opportunities peculiar to all simulators. The most striking example of incomplete implementation is the simulation of the operation of the STP protocol.

The GNS3 emulator is a graphical interface for the Dynamips emulator under Linux, Windows and Mac OS X operation systems, the main advantage of which is the use of the current Cisco IOS firmware. But the firmware itself is not included in the program and should be obtained separately, for example, under the program Networking Academy Maintenance – Image & Hardware Support. The GNS3 allows you to connect virtual machines VirtualBox or VMware Workstation and create quite complex and intuitive topologies. It supports the ability to connect to the local network and the Internet. In addition, there is the possibility of emulating the operation of Cisco ASA.

The main drawback of the emulator can be called a strict limitation on the number of devices that can be used. You can only use the devices that the Dynamips developers provided, for example, there is no emulation of the Catalyst series. Also, it is impossible to use the latest firmware versions of IOS 15. In addition, complex topologies require considerable hardware resources on the computer on which the emulator is being used.

Emulated Virtual Environment is a free multi-vendor and multi-user platform for creating and modeling a wide variety of network topologies including routers, switches, security devices, workstations and servers. The emulator has wide support for a large number of equipment from various vendors, such as Cisco, Juniper, HP, Checkpoint, Aruba, Alcatel. The number of equipment units that can be started is limited only by the hardware capabilities of the computer on which the emulator is opened (Fig.2).

The main advantage of EVE is the wide support of Cisco equipment. In the emulator you can add Cisco IOL-images, images from VIRL (vIOS-L2 and vIOS-L3), ASA Firewall (both ported 8.4 (2), 9.1 (5), and official ASAv), Cisco IPS, XRv and CSR1000v, Dynamips from GNS, Cisco vWLC and vWSA. The emulator implemented almost full support for the L2 switching level with insignificant limitations. EVE places low demands on the hardware resources of the computer on which it is opened. The project implements a completely graphical interface for creating a topology similar to GNS3, and support for Microsoft Visio images is included.

Match the characteristics and corresponding types of routers

Not suitable for topologies where it is required to use several routers

New networks are added in a table of a router automatically

Numbers mean the link cost

Static routing

Usually used in stubnetworks

Receiver

Dynamic routing

Receiver

Receiver

What two statements about protocols of classless routing are correct (choose two variants)?

- ☐ Send data on subnet mask in router updates
- ☐ Send full update of a table of a router to all neighbours
- ☐ Supported by protocols of RIP version 1
- ☐ Allow to use both subnets 192.168.1.0/30 and 192.168.1.16/28 in one topology
- ☐ Reduce volume of address space available in the organization

Look at the picture. Network uses OSPF. What type of rout will be chosen by OSPF mechanism for sending data packages from Net A to Net B?

- ☐ R1, R2, R5, R7
- ☐ R1, R3, R5, R7
- ☐ R1, R3, R6, R7;
- ☐ R1, R4, R6, R7;
- ☐ R1, R3, R5, R6, R7

Fill in the blank. Do not use abbreviations or contractions.

When setting the RIPv2 the command specifies the router tells the router to distribute the static routing automatically.

Fig.3. Examples of questions in the examination system of Networking Academy

Just like in GNS3, in EVE firmware of the devices are not part of the emulator, so the process of setting up EVE can cause difficulties for an unprepared user. However, the manufacturer's website contains a large number of instructions for adding certain images to the emulator.

Thus, despite the presence of a significant number of limitations, the Cisco Packet Tracer simulator is the simplest, most convenient and sufficient for the initial stage of training in network technologies solution. At the same time, its capabilities are not enough to prepare for exams for the CCNA industrial certificate, as well as further training at the Cisco Certified Network Professional level (CCNP). The most suitable environment for advanced training in the field of network technologies today is EVE.

Examination system allows you to take both exams in chapters, and final exams at the end of the course. For each exam, there are several variants of question sets that are selected at random. Questions follow in a random order and possible answers are necessarily mixed. Answers to questions can be of various types: one-variant, multiple variants, requiring an interactive task or entering the correct answer from the keyboard (Fig.3). To pass the exam a student should get 75 % of correct answers.

All student grades are reflected in the evaluation sheet and communicated to them by e-mail specified during registration. The instructor has access to the grades of all students of the group. The final grade for the course is formed as a weighted sum of the grades for the exams for the chapters and the grades for the final exam. Weighting factors are set by the instructor.

In the NetAcad system, there is an information section called Calendar, in which the instructor can set the dates of important events, for example, examinations by chapters. These events will be displayed for a student on the main page of the learning system interface in chronological order. Also, each student, using a special link, can connect the calendar channel to his personal calendar and receive notifications on both personal computers and mobile devices used by him.

The instructor can communicate with students individually using a message system or using announcements for the entire group. In this case, each message or announcement together with the attachments is duplicated to each student on his e-mail, specified at registration. The answer to the received letter is automatically added as a comment to the announcement or message in the corresponding section.

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The time a student spent reading an interactive textbook, the number of read pages, interactive assignments, and test papers after each chapter are displayed in the analytics section. The data are presented both in numerical form and in the form of convenient graphs and histograms, accompanied by detailed signatures and comments. At the same time, information can be viewed both for each student separately, and for the whole group.

Students who successfully completed the Academy course receive a certificate from Cisco, a letter of gratitude from the CEO of Cisco and a discount of 58 % when passing the exam for an industrial certificate that confirms the practical skills required to work in the field of information and communication technologies.

The interdepartment center of modern information technologies «The Cisco Networking Academy» of the Mining University has been successfully training students and IT specialists of the Russian mineral resource complex for more than five years (more than 200 people annually).

At the Economic University of Bratislava (Slovak Republic), e-learning tools are also actively used for training students in the field of information technology [3, 7]. In particular, the training materials of the courses «Infrastructure of Information Systems», «Database Systems», «Innovative Aspects of Application of Information Technologies» and «Extended Use of Databases» were prepared using the basic rules for the creation of electronic teaching materials and placed in LMS MOODLE system on the server. The materials are available in Slovak, Russian and English and have been prepared in cooperation with teachers from several universities, such as the University of International Business (Almaty), the Eurasian National University named after LN Gumilyov (Astana) and the Institute for Social and Humanitarian Knowledge (Kazan).

At present, the course «Database Systems» is read to students of the University of International Business (Almaty) and the Dagestan State Institute of National Economy (Makhachkala) using electronic learning and information and communication technologies.

The training schedule is developed in accordance with the requirements of the university and the possibilities of a foreign teacher. In particular, to begin the course, a foreign teacher is invited to the university for two weeks. During this time, he must read introductory lectures and conduct introductory practical exercises, teaching students to use LMS Moodle. The students also need to work out the modes of passing the assignments, conducting remote consultations and getting remote access to the database management system.

Later all training is carried out remotely. Practical classes are held on a weekly basis. The purpose of the classes is to explain the tasks from the electronic learning system and check the assignments made by the students. During classes it is also possible to assess the current level of student preparation by giving them small tasks to solve in real time mode. For live communication with students, the Skype communication system is used, for the direct connection to the desktop of the student's personal computer – the TeamViewer application.

The total grade for the course is formed from the performance results for current assignments and the final exam, which consists of theoretical and practical parts. The theoretical part consists of an oral answer to a question, and a practical part has a form of an individual task to be solved by a student. The answer to the theoretical question is carried out using the Skype system, and the process of solving an individual task is recorded on video and controlled by access to the student's desktop.

Thus, the use of modern electronic learning tools allows to substantially improve the quality of training of specialists in the field of information technology and to increase the inclusion of teachers in the international educational space.

REFERENCES

1. Katuntsov E.V., Makhovikov A.B. NetAcad – e-learning system of the Cisco Networking Academy. Sbornik nauchnyh trudov III Mezhdunarodnoj nauchno-metodicheskoy konferencii «Sovremennye obrazovatel'nye tehnologii v prepodavanii estestvenno-nauchnyh i gumanitarnykh disciplin». Sankt-Peterburgskij gornyj universitet. St. Petersburg, 2016, p. 289-293 (in Russian).
2. Katuntsov E.V. Comparison of virtual environments for laboratory work on network technologies. Sbornik nauchnyh trudov III Mezhdunarodnoj nauchno-metodicheskoy konferencii «Sovremennye obrazovatel'nye tehnologii v prepodavanii estestvenno-nauchnyh i gumanitarnykh disciplin». Sankt-Peterburgskij gornyj universitet. St. Petersburg, 2016, p. 284-289 (in Russian).



3. Kultan J. The use of videoconferences in the organization of training in Russian at the Economic University in Bratislava. *Modernizacija kazahstanskoy jekonomiki: aktual'nye problemy postkrizisnogo razvitija: Sbornik materialov XIV mezhdunarodnoj nauchno-prakticheskoy konferencii*. Almaty: Universitet mezhdunarodnogo biznesa, 2010, p. 16-21 (in Russian).
4. Makhovikov A.B. The use of Internet conferencing systems as a way to improve the efficiency of mining management. *Zapiski Gornogo instituta*. 2011. Vol. 191, p. 262-266 (in Russian).
5. Makhovikov A.B., Stoljarov K.V., Strel'nikova A.V., Chernov M.A. Methods of solving some problems arising in the development of Internet conferencing systems. *Zapiski Gornogo instituta*. 2011. Vol. 193, p. 321-325 (in Russian).
6. Alves G.R. Large and small scale networks of remote labs: a survey. *Advances on Remote Laboratories and E-learning Experiences / University of Deusto*. Bilbao, 2007, p. 15-34.
7. Kultan J., Serik M., Alzhanov A. Information technology is an object, tool and tool of training. *Information Technology Applications*. 2012. Vol. 1, p. 55-69 (in Russian).
8. Lustigová Z., Lusting F. A New Virtual and Remote Experimental Environment for Teaching and Learning Science. Berlin: Springer, 2009, p. 75-84.
9. Makhovikov A., Makhovikova I. Use of Hidden Markov models for evaluation of Russian digits pronunciation by the foreigners. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*. 1999. N 1692, p. 152-155.
10. Ma J., Nickerson J.V., Hands-On, simulated, and remote laboratories: A comparative literature review. *ACM Computing Surveys*. 2006. Vol. 38. N 3, p. 1-24.

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