# Application of Educational Environments when Learning at Accelerated Programs

Sergey S. Vaulin

Ural Federal University named after first President of Russia B. N. Yeltsin,
32 Mira Str., Ekaterinburg, 620002, Russia
s.s.vaulin@urfu.ru

**Abstract.** The experience of the use of educational environments in training under accelerated programs of higher professional education is considered. The specifics of accelerated learning are analyzed. A compact laboratory workshop on network technologies is proposed, which fully covers the material of the network academy, used in learning.

**Keywords:** Teaching methodology; Educational environments; Accelerated learning; Laboratory workshop; Computer networks; Network Equipment configuration; Distributed systems



Centre for Accelerated Learning Engineering School of Information Technologies, Telecommunications and Control Systems UrFU provides students with accelerated undergraduate programs, the form of study is full-time and part-time. Directions "Computer Science and Computer Engineering" and "Software Engineering" (In 2019, a new technique was carried out in the field of "Applied Computer Science").

Full-time part-time students study 2 days a week - one working day (different for different groups) and Saturday. Persons who have completed specialized secondary specialized educational institutions are accepted, and, in fact, the reduction in the training time is due to the re-entry of the disciplines that they have already studied. As a rule, they all work in their specialty. Accordingly, the features of training in this form are obtained as follows:

- Shortened training periods - there is very little classroom time allocated for each discipline.
- Trainees are already specialists in their field with practical experience.
- Low intensity of training (2 days a week), which entails a high rate of development of the discipline material.
- The great importance of independent work is generally characteristic of part-time and distance learning.

To successfully master the material, you have to do the following:

- Students at the beginning of the study of the discipline receive the necessary guidelines and textbooks (mostly in electronic form). For external students, installation lectures are required in advance.
- During the semester, students also receive all supporting materials - presentations, demos, etc.
- The interaction of students and teachers, in addition to the audience, is also carried out by e-mail.
- In the educational process, educational environments are widely used that can significantly automate the learning process.

Consider the latter in more detail.

Two types of educational environments are used: moodle [1] and the Cisco Networking Academy environment [2].

The first is universal, allows you to work with any discipline. The teacher places training materials and tests, exams and tests pass automatically, objectively and quickly. The system is regularly supported by university services and is widespread.

Certainly requires an individual approach to each discipline, it is required to develop and upload training materials to the server.

The second is specialized, used for training at the Academy. In our case, we use the courses of the Routing and Switching line of CCNA (Cisco Certified Network Associate) qualification. Material can be integrated into the educational process in the first two (of the four available) parts of the course (which corresponds to the initial qualification of CCENT - Cisco Certified Entry Networking Technician). For more - there is simply not enough class time.

This material can be used for groups of disciplines dedicated to:

- Technologies for designing and administering computer networks.
- Distributed systems development technologies in the client-server architecture.
- Information Security Technologies.

The environment contains ready-made material (interactive tutorial), a tool for modeling networks (Packet Tracer), test material. It allows you to provide almost complete support for the educational process in the first group of disciplines, up to passing exams and accounting for laboratory work. Of course, additional material is required, since the basic principles of networks are presented in the textbook rather superficially and often - controversially from a methodological point of view. Still, the textbook is the material of a leading manufacturer of network equipment, and is primarily dedicated to teaching exactly how to configure this equipment.

The environment includes a laboratory workshop designed for learning from scratch, without additional basic training. It requires a significant amount of class time, has many repetitions, and the program is not very suitable for accelerated learning. It is possible to integrate this laboratory workshop into the educational process of the institute (IRIT-RTF UrFU) full-time education, but for an accelerated form of classroom time is not enough for this. I had to develop an abbreviated set of laboratory works, which, nevertheless, completely cover the entire course material (the first 2 parts of the

CCNA course). At the same time, we take into account that our students have experience in the specialty, experience with a variety of computer equipment, basic training in the framework of usually specialized secondary specialized education. The laboratory workshop is held in a specialized laboratory on real equipment, Packet Tracer is used only to prepare for classes.

The first part of the CCNA course covers the following topics:

- Setting up a network operating system.
- Network Protocols and Communications.
- Network access.
- Ethernet.
- Network layer.
- IP addressing.
- Subnetting IP Networks.
- Transport level.
- Application level.

Accordingly, the laboratory workshop provides for the first, familiarization work on the basic setup of equipment. We assemble the simplest network from the switch and two computers, develop an addressing plan (IPv4), statically configure the end nodes (these computers), and configure the switch for secure remote control.

A typical basic configuration of the Cisco IOS operating system is as follows:

*hostname ...*
*enable secret class*
*service password-encryption*
*no ip domain lookup*
*banner motd # ... #*
*username cisco secret cisco*
*ip domain-name ...*
*crypto key generate rsa modulus 1024*
*ip ssh version 2*
*interface vlan 1*
*ip address ... ...*
*description ...*
*no shutdown*
*line console 0*
*login local*
*logging synchronous*
*line vty 0 4*
*login local*
*transport input ssh*
*end*

We set the following:

- device name;

- password to access privileged mode;
- prohibition of password output without encryption;
- prohibit name resolution (to speed up configuration);
- set a warning message (so-called. “Banner”);
- set the username and password for access to user mode;
- configure SSH and generate keys with a length of 1024 bits for it;

We configure the virtual interface of the VLAN 1 switch, set its IP address and mask, turn it on.

When configuring the console line, we indicate the need to authenticate the user using the local password database and set the automatic recovery mode for a line broken by system messages.

When configuring virtual terminal lines, we additionally limit the ability to remotely control only the SSH protocol.

This basic setting is further repeated in each laboratory work.

The second work of the laboratory workshop provides for the assembly of the network already from two switches, two computers and a router. As part of this work, students:

- develop an addressing plan (two IPv4 networks);
- statically configure end devices by specifying the address of the router interface as a gateway;
- configure switches for secure remote control (see above), additionally specifying the address of the router interface as a gateway;
- configure and enable router interfaces; Configure it for secure remote management;
- check the availability of all devices and the ability to remotely control from any computer.

The third work of the laboratory workshop provides for the assembly of a more complex network with point-to-point connection of two routers (Fig. 1). As part of this work, students:

- Develop an addressing plan (three IPv4 networks using VLSM - variable-length masks);
- statically configure all devices;
- configure all intermediate devices for secure remote management;
- configure routing tables on the router, prescribing routes to remote networks;
- check the availability of all devices and the ability to remotely control from any computer.

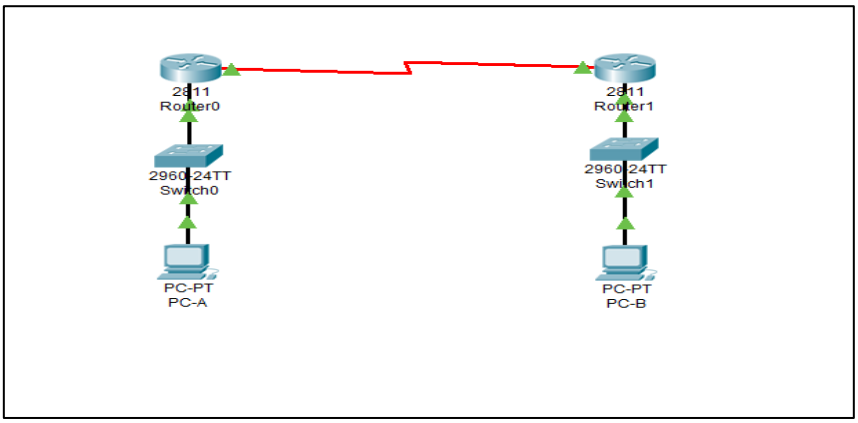


**Fig. 1.** Network for the third laboratory work

The fourth work of the laboratory workshop is based on the same network, but involves the use of the TCP / IP v6 protocol stack. As part of this work, students:

- develop an addressing plan (three IPv6 networks);
- configure all devices by setting global individual and link-local addresses for them;
- put the switches in dual-stack mode (IPv4 and IPv6);
- configure all intermediate devices for secure remote management;
- configure routing tables on the router, prescribing routes to remote networks;
- check the availability of all devices and the ability to remotely control from any computer.

Work with the TCP / IP v6 protocol stack in the workshop pays great attention to how promising and equitable with TCP/IPv4.

The considered 4 works are fully consistent with the material of CCNA Part 1 and are designed for 4 academic hours each.

The second part of the CCNA course covers the following topics:

- Basic concepts and switching settings.
- Virtual Local Area Networks (VLANs).
- Routing concept.
- Inter-VLAN Routing.
- Static routing.
- Dynamic routing.
- Access Control Lists(ACL).
- DHCP protocol.
- IPv4 Network Address Translation.

The first work of part 2 is comprehensive, it provides a breakdown of networks into VLANs and the setting of port security functions (binding by MAC addresses). The circuit is assembled (Fig. 2). As part of this work, students:

- develop an addressing plan (two IPv4 networks), breaking the network into 2 VLANs;
- configure all devices (switches - for secure remote control);
- configure binding by MAC addresses;
- check for lack of interaction between computers of different VLANs;
- swap computers in the same VLAN and observe the protection response;
- return computers to their place and restore network operation.

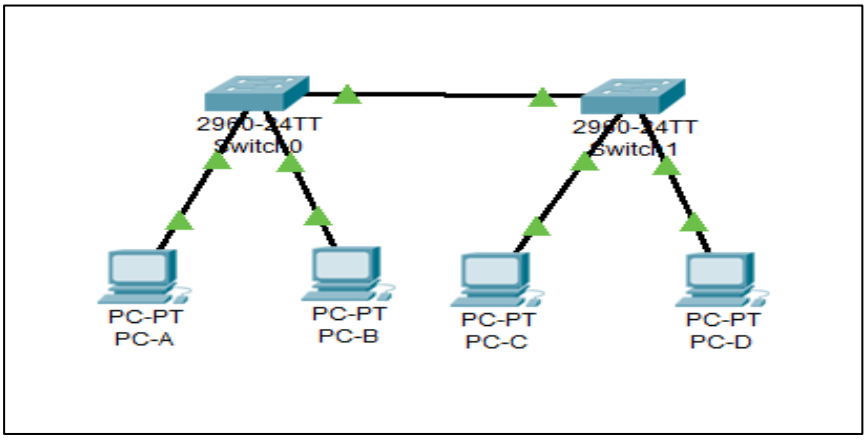


**Fig. 2.** Network for the first laboratory work of the second part

The second work is about routing between VLANs. A router is added to the network according to Fig. 2 and it is configured in the router-on-a-stick configuration, the presence of routing is checked. Then the router is turned off, one of the switches is switched to the Layer 3 switch mode and the routing between the virtual interfaces of the switch is configured.

The third work is devoted to static routing. A “triangle” of three routers is being assembled (Fig. 3), as part of this work, students:

- develop an addressing plan (3 local networks for each router (one is real, two are modeled using Loopback interfaces); addresses are selected so that they can be addressed with one summary route;
- on each router, the total routes to these networks are prescribed, supported by backup “floating” routes;
- turning off the interfaces of the routers, tracing the routes, observe the change in packet routes;

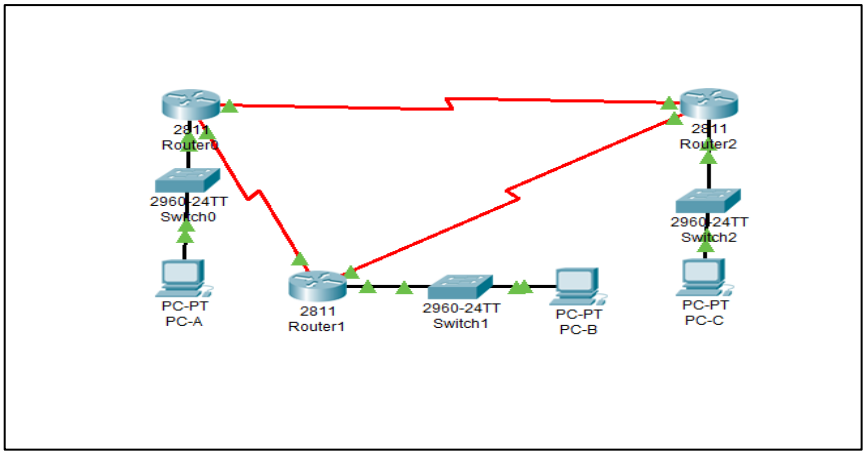


**Fig. 3.** Network for the third laboratory work of the second part

The fourth and fifth works are devoted to the dynamic routing protocols RIP and OSPF (one area). The same scheme is used, but the named protocols control routing. Demonstrates route changes when disabling router interfaces. For OSPF, route changes are additionally demonstrated when the advertised declared throughput and channel metrics change. OSPF is currently not part of CCNA Part 2, but is extremely important from a practical point of view.

The sixth work focuses on access control lists (ACLs) for configuring a firewall. The circuit is assembled and configured (Fig. 4), the interaction of Switch0 and Switch2 networks is ensured, the absence of the interaction of Switch0 and Switch1 networks for IPv4 and IPv6.

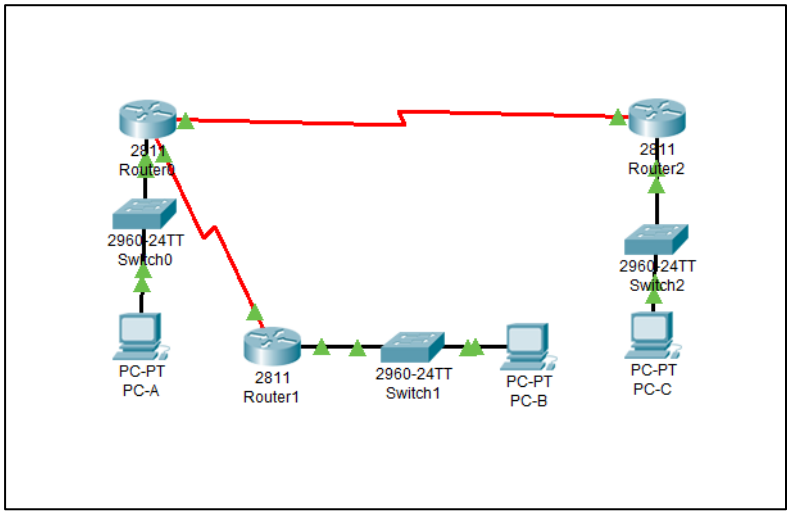


**Fig. 4.** Network for the sixth laboratory work of the second part

The seventh work on the basis of the same network differs in that for IPv4 address translation (PAT) is configured on Router1 (Switch1 - internal network); because of this, packet filtering rules are modified. In addition, end nodes receive addresses dynamically using DHCP; for both protocol stacks, 2 DHCP servers are configured on the routers (on Router1 and, for example, on Router2; requests from end nodes the Switch0 network are relayed to Router2).

In total, in 2 parts, 7 works of 4 academic hours each are obtained, which completely cover the material of the textbook and exams. Students take exams (in the form of tests in Russian or English) at home, the final exam in part 1 also, the final exam in part 2 in an audience in a controlled environment; the results of the final exams are translated into a 5-point system and are counted as an exam in this discipline.

In the second and third groups of disciplines, the medium contains only part of the material, and is an addition to the lecture course. We also had to develop our own laboratory workshop, using materials including an interactive textbook and the same laboratory. In addition, the environment (tutorial and Packet Tracer) is used for course design.

Thus, the use of educational environments for training in accelerated programs allows for such training in a short time with high quality

## References

1. The Moodle Project. URL: https://moodle.org, last accessed 2019/11/15.
2. Cisco Network Academy. URL: https://www.netacad.com, last accessed 2019/11/15.