

INTEGRATING CISCO SYSTEMS' EDUCATIONAL PROGRAMS IN ICT SECURITY ACADEMIC CURRICULA

Oleksandr GORDIEIEV, Taras LOBUR, and Ruslan KOZAK

Abstract: Leading companies in the field of ICT often provide training courses. Such courses are found attractive by students, especially students specializing in technical disciplines. In this article, we review courses provided by Cisco Systems, describe their organization, nomenclature and structure, and provide recommendations on their use in the academic curricula in the field of information and communications security. The inclusion of such courses in the academic curricula is considered beneficial in terms of competitiveness of graduates on current and foreseen labour markets.

Keywords: IT specialist, curriculum, certification program, CCNA Security curriculum, Cisco Systems' courses.

1 Introduction

Modern informative-communication technologies create certain requirements for the specialists which use these technologies in their work. We observe a serious break in knowledge and skills which students get during studying at university and requirements, produced to the graduating students from the side of information technologies industry (IT-industry). It happens because of the sharp deficit of specialist in information technologies (IT-specialists), possessing necessary jurisdictions, and also with the necessity of development of the system of instruments, allowing to promote their labour productivity.

The additional teaching on the authorized courses is used for diminishing of this break, developed by large industrial companies (vendors), such as Cisco, Microsoft, IBM, and Oracle. But such education has to be got already after the university or within the framework of the separate joint programs of IT-companies with educational establishments.

Objectively universities are not always ready to include the studies of new informative-communication technologies in an educational process (in curriculum). Vendors offer certification courses to support the process of preparation of specialists separately from universities. The value of such courses is in developing simultaneously with the output of new technologies; they are directed on forming competencies in certain fields, sharply claimed by a labour market and necessary for the use of such technologies (see Table 1).

Vendors and some other certification providers represent the full certification cycle which includes educational materials, examinations, systems of the independent testing and, finally, certification. The system appeared so claimed, that even in spite of crisis, demonstrates strong growth.¹

Table 1: Growth in the number of IT specialists with various types of certification (in thousands).²

	2000*	2007*	2008*
Cisco	35	600	700
Microsoft	1048	3200	4351
IBM		800	
Novel	563		
Oracle	24	350	440
HP		130	130
SAP		185	
Sun		456	
Other vendors	52		50 +
CompTIA	166	800	1000
CISSP	1.5	50	60
ISEB		220	279
EXIN		350	456
ISACA		56	69
EUCIP		1.5	2
Other	68		
Bcero:	1957	7198	9000

Additionally, the actuality of the approach, which fixes up the problem of practical preparation of students, is linked with the arising up from a crisis necessity of business to form the effective teams of ICT-specialists, who have cross-competencies. In this case the educational systems will produce flexible instruments for development of curricula for future IT-specialists.

2 Problem Statement

Integration of prepared industrial courses to university academic curriculums can do students (specialists) more qualitative and will make set of tasks, among which:

- at first, the graduating students of technical specialties of universities often run into the problem of the lack of experience or its absence in realization of engineering's tasks and participating in the real projects. As a rule, it induces a student of senior courses (and not only) to be engaged in labour activity of industrial companies. Such combination of activity results in worsening of progress or his deduction from an university because of non-fulfilment of curriculum;
- secondly, during preparation of tasks for practical or laboratory works teacher has to formulate (raising of task) interesting and actual industrial tasks (projects). It requires a lot of experience from university staff (for example, professors), large time and human resources.

Modern known industrial technological companies, such as Cisco Systems, Microsoft, IBM, Intel etc., offer educational and industrial courses, which are oriented to the proper technologies. Integration of the prepared courses of industrial companies into the curricula of universities can do the process of preparation of specialists (students) more high-quality and decide the considerable complex of tasks, such as:

- increase of competitiveness of graduating students of universities due to harmonization of the content of educational programs with the rate of development and update of technologies in the real sector of economy;
- enriching and development of competitive models of graduating students with new components, claimed at the labour market;
- bringing into an academic environment of the main educational programs the hi-tech companies for planning and realization.³

Teaching on these courses is realized in special educational centres and in other forms of partnerships. Technological jurisdictions of IT vendors at the same time are inalienable part of more wide jurisdictions of IT-specialists, however single methodological base, which allows dynamically to determine and forecast complex jurisdic-

tions of IT-specialists for actualization of the educational modules and integration them in curricula, now is not developed.

Hence, the purpose of the article is to describe the approach, which can solve the task of practical preparation of students due to introduction in the educational plans of industrial technological courses.

Educational Structure of Cisco Systems

As an example in the article educational activity of the known industrial Cisco Systems company will be considered. Preparation of students in the field of ICT on the base of educational courses of Cisco is possible on the next directions: D.1 Architect; D.2 Cloud; D.3 Collaboration; D.4 Data Centre; D.5 Design; D.6 Industrial / IoT; D.7 Routing & Switching; D.8 Security; D.9 Service Provider; D.10 Wireless. For such directions the followings levels of qualification are possible:

Q.1 Entry. Entry-level Cisco certifications begin either with Cisco Certified Entry Level Technician (CCENT) certification as an interim step to the Associate-level, or a Cisco Certified Technician (CCT) certification. With a CCENT certification, a network professional demonstrates the skills required for entry-level network operating and support positions - the starting point for many successful careers in networking. Cisco Certified Technicians have the skills to diagnose, restore, repair, and replace critical Cisco networking and system devices at customer sites;

Q.2 Associate. Cisco Certified Network Associate (CCNA) is certification is for plant administrators, control system engineers and traditional network engineers in the manufacturing, process control, and oil and gas industries, who will be involved with the convergence of IT and Industrial networks.

Q.3 Professional. The Professional level in the Cisco Certification program recognizes a more advanced networking knowledge base and skills set. Each certification verifies a set of different technology skills to meet the needs of varying job roles;

Q.4 Expert. The Cisco Certified Internetwork Expert (CCIE) certification is accepted worldwide as the most prestigious networking certification in the industry. Network Engineers holding an active Cisco CCIE certification are recognized for their expert network engineering skills and mastery of Cisco products and solutions. The CCIE community has established a reputation of leading the networking industry in deep technical networking knowledge and are deployed into the most technically challenging network assignments;

Q5. Specialist. The Specialist designation certifies specific expertise of technical professionals, including those with Cisco Career Certifications at the associate, professional or expert levels. By earning specialist certifications, network professionals can enhance their core networking knowledge in technologies such as security, data centre or video.

Possible industrial courses and their correlations with directions of preparation and qualifications are presented in Table 1. Separately, within the framework of qualification Q5 Specialists, the courses, presented in Table 2, are offered.

The following idea was fixed in basis of development of business of Cisco Systems company: at first, development of technologies and active network equipment, and secondly, creations of educational internetwork for preparation of specialists in area of computer networks. Realization of idea was successful. A company successfully develops the technologies and sells network equipment. International educational structure of Cisco networking academies was created. Over 10 000 Cisco academies, which function in 165 countries of the world, are today counted. The quantitative and per cent distributing of Cisco academies is presented on a Figure 1.

Nomenclature of Cisco Systems' Courses

Nomenclature of courses of network academies of Cisco covers wide spectrum of ICT⁵:

- IT Essentials: learn how to build and set up a computer and connect it securely to a network and first step to an IT career, duration – 70 hours;
- CCNA Routing and Switching: learn networking fundamentals and advanced concepts with hands-on practice and simulations to develop skills, duration – four courses (280 hours);
- CCNA Security – learn to design, implement, and support networked devices to fill the growing demand for network security professionals, duration – 70 hours;
- CCNP Routing and Switching: advance networking skills to support converged enterprise networks, duration – three courses (210 hours);
- Introduction to the Internet of Everything: an overview of how the connection of people, process, data, and things to the network will transform business, operations, and careers, duration – 20 hours;
- Introduction to Cybersecurity: learn about network security trends, how to mitigate risk, and the growing demand for cybersecurity experts, duration – 15 hours;

Table 2: Nomenclature of Cisco courses.⁴

Qualifications Directions (technologies)	Q.1 Entry	Q.2 Associate	Q.3 Professional	Q.4 Expert
D.1 Architect				D.1 CCAr Architect
D.2 Cloud		D.2 CCNA Cloud	D.2 CCNP Cloud	
D.3 Collaboration		D.3 CCNA Collaboration	D.3 CCNP Collaboration	D.3 CCIE Col- laboration
D.4 Data Center		D.4 CCNA Data Center	D.4 CCNP Data Center	D.4 CCIE Data Center
D.5 Design	D.5 CCENT Design	D.5 CCDA Design	D.5 CCDP Design	D.5 CCDE Design
D.6 Industrial / IoT		D.6 CCNA Industrial		
D.7 Routing & Switching	D.7 CCENT	D.7 CCNA Routing and Switching	D.7 CCNP Routing and Switching	D.7 CCIE Routing and Switching
D.8 Security	D.8 CCENT	D.8 CCNA Security	D.8 CCNP Security	D.8 CCIE Security
D.9 Service Provider		D.9 CCNA SP	D.9 CCNP SP	D.9 CCIE SP
D.10 Wireless	D.10 CCENT	D.10 CCNA Wireless	D.10 CCNP Wireless	D.10 CCIE Wireless
D.11 Other Certifications	D.11 Certified Technician			
CCAr – Cisco Certified Architect; CCIE – Cisco Certified Internetwork Expert; CCDE Cisco Certified Design Expert; CCNP – Cisco Certified Network Professional;		CCDA – Cisco Certified Design Associate; CCNA – Cisco Certified Network Associate; CCENT – Cisco Certified Entry Networking Technician.		



Figure 1: Distribution of Cisco networking academies on continents.⁶

- NDG Linux Essentials: learn the fundamentals of the Linux operating system and command line and basic open source concepts, duration – 70 hours;
- NDG Introduction to Linux I: learn how to perform maintenance tasks on the command line, install and configure a computer running Linux, and configure basic networking, duration – 70 hours;
- Entrepreneurship: develop an entrepreneurial way of thinking to improve your job opportunities and advance career, duration – 15 hours;
- Be Your Own Boss: learn how to run a successful technology business from notable technologies, duration – 8 hours;
- Get Connected: gain essential skills for the workplace with this introduction to computers, search, email, and social media, duration – 30 hours.

Basic courses IT Essentials, CCNA Routing and Switching, CCNA Security include the next elements:

- multimedia presentations (lectures);
- hand-on labs;
- practical works;
- tests after each chapter;
- final test course.

Other courses are limited to only presentation materials and tests, and give possibility to an instructor to fill and adapt them. It is important that practical tasks are executed by students both on the multifunction programmatic emulator of Packet Tracer and on the real equipment of Cisco. Every student has a possibility to choose industrial certification according to qualification level.

Table 3: Cisco courses nomenclature for specialist qualification.

Q5. Specialist			
Business			
Cisco Enterprise IT Business Specialist	Cisco Business Specialists – for sales professionals	Cisco Learning Virtual Classroom Instruction	
Data Center			
Data Center Unified Computing	Data Center Unified Fabric	FlexPod	
Internet of things			
Cisco Industrial Networking Specialist			
Network Programmability			
Cisco Business Application Engineer Specialist	Cisco Network Programmability Developer Specialist	Cisco Network Programmability Design Specialist	Cisco Network Programmability Engineer
Security			
Cisco Cybersecurity Specialist			
Operating System Software			
Cisco IOS XR Specialist			
Service Provider			
Cisco Service Provider Mobility CDMA to LTE Specialist	Cisco Service Provider Mobility UMTS to LTE Specialist		
Collaboration			
Cisco Unified Contact Center Enterprise Specialist	Cisco TelePresence Solutions Specialist	Cisco Video Network Specialist	

Integration of Industry Courses in Educational Curricula

Educational courses from Cisco Company can be plugged in the curriculum of preparation of students of technical specialities. There is also possibility to choose qualification level from Entry to Expert. Plugging of Cisco courses in curricula requires accounting their sequence. For example, such courses as Security or Wireless can reach, only after course of Routing and Switching. The general sequence of study of Cisco courses is presented is detailed in a company study.⁷

Integration of networking academy courses must be performed according to Cisco Networking Academy Membership Guide, which defines participation policies of educational organizations, which participate in networking academy program. Cisco company also define framework and support mechanisms for participating in the Networking Academy community, including the various options institutions have for engaging in the community and managing academy success, and the policies applicable to all members. The policies also identify a number of program requirements with which participants in the Cisco Networking Academy program must comply.

Except for organizational and normative-legal (copyrights, confidentiality) requirements, policies contain general requirements to teaching of Cisco courses. Some of these requirements are:

- academies must ensure that only Cisco Networking Academy registered students are permitted of access to online Cisco academy web-portal (NetAcad) and skills-based assessments to maintain the integrity of the Cisco Networking Academy program;
- academies must ensure that all students taking the class are enrolled in NetSpace and use the Networking Academy assessment system to provide chapter and final assessments. Academies must also ensure that results are recorded in the online grade book including online final exam scores, skills assessment scores, course feedback, and course completion status;
- academies must ensure that all classes of Cisco developed certification aligned courses, i.e. ITE, CCNA, CCNA Security and CCNP, meet the following criteria:
 - instructor led;
 - a minimum of four weeks in duration;
 - approximately 70 hours of student engagement with course material.

Content of the Course “Security in Computer Networks”

This section presents the main characteristics of the course “Security in computer networks” of CCNA qualification. CCNA Security provides an in-depth, theoretical,

and hands-on introduction to network security, in a logical sequence driven by technologies. CCNA Security includes the following features:

- students develop an in-depth, theoretical understanding of network security principles as well as the tools and configurations available;
- the courses emphasize the practical application of skills needed to design, implement, and support network security;
- hands-on labs help students develop critical thinking and complex problem-solving skills;
- Cisco Packet Tracer simulation-based learning activities promote the exploration of networking security concepts and allow students to experiment with network behaviour and ask “what if” questions;
- innovative assessments provide immediate feedback to support the evaluation of knowledge and acquired skills;
- can be delivered in-person or in a blended distance learning (BDL) environment.

The list of modules and their purpose is presented in Table 4.

Upon completion of the CCNA Security course, students will be able to perform the following tasks:

- describe the security threats facing modern network infrastructures;
- secure network device access;
- implement AAA on network devices;
- mitigate threats to networks using ACLs;
- implement secure network management and reporting;
- mitigate common Layer 2 attacks;
- implement the Cisco IOS firewall feature set;
- implement an ASA;
- implement the Cisco IOS IPS feature set;
- implement site-to-site IPSec VPNs;
- administer effective security policies.

3 Recommendations for teaching “Security in Computer Networks”

The CCNA Security curriculum consists of:

- one semester-long (approximately 70-hour) course;
- 11 chapters, quizzes, and chapter exams;

Table 1: Selected chapters in Cisco's security course.^{8,9}

#	Chapter name	Goal
1	Modern Network Security Threats	Explain network threats, mitigation techniques, and the basics of securing a network
2	Modern Network Security Threats	Secure administrative access on Cisco routers
3	Authentication, Authorization and Accounting	Secure administrative access with AAA
4	Implementing Firewall Technologies	Implement firewall technologies to secure the network perimeter
5	Implementing Intrusion Prevention	Configure IPS to mitigate attacks on the network
6	Securing the Local Area Network	Describe LAN security considerations and implement endpoint and Layer 2 security features
7	Cryptography	Describe methods for implementing data confidentiality and integrity
8	Implementing Virtual Private Networks	Implement secure virtual private networks
9	Managing a Secure Network	Given the security needs of an enterprise, create and implement a comprehensive security policy
10	Implementing the Cisco Adaptive Security Appliance (ASA)	Implement firewall technologies using the ASA to secure the network perimeter

- one pre-test, one certification practice exam, one practice final, one final exam and skills-based assessment;
- 16 hands-on labs;
- 13 Cisco Packet Tracer activities and one Packet Tracer Practice Skills Based Assessment (SBA).

CCNA Security curriculum prepares students for the new Implementing Cisco Network Security (ICNS) certification exam (210-260), leading to the CCNA Security certification.

The United States Department of Defense has certified the Cisco CCNA Security Certification as DoD 8570.01-M compliant. The DoD 8570 Directive provides guidance and procedures for the training, certification and management of all DoD employees performing Information Assurance functions in their line of duty. CCNA Security has been approved for DoD Information Assurance Technician Levels I and II. The CCNA Security Certification also meets the ISO 17024 standard accredited by ANSI. More information can be found on the Standards recognition page.

4 Conclusions

Theses, offered in the article, are another step on the way of rapprochement of level of requirements of employers to the graduating students of educational establishments, bachelors and master's degrees which are able to confirm the qualification in the systems of European vendor certifications, and also acknowledged international Cisco certifications after introduction of courses in curricula.

Due to this introduction students in the process of studying will be able to obtain theoretical knowledge and real practice on modern network technologies, and also to pass certification examinations on Cisco technologies, that give them advantage at the market of labour in the field of ICT.

Acknowledgement

We thank to all colleagues from Britain, Estonia, Italy, Bulgaria, Sweden and Ukraine for full support and possibility of discussions and development of SEREIN courses as part of the TEMPUS SEREIN project (Project Reference: 543968-TEMPUS-1-2013-1-EE-TEMPUS-JPCR). We are, of course, indebted to the course development teams.

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About the Authors

Oleksandr GORDIEIEV is with the University of Banking in Kyiv, Ukraine.

Taras LOBUR and Ruslan KOZAK are faculty members of the Ternopil Ivan Pul'uj National Technical University, Ternopil, Ukraine.