Enterprise infocommunication infrastructure in training of IT-professionals

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Abstract. The paper presents the enterprise infocommunication infrastructure and its management features as the influenced factors to the training of IT-professionals within the traditional educational process. The paper presents how the educational content of modern IT specialists can be developed on the basis of the infocommunication infrastructure of a modern enterprise and the interdisciplinary connections. Such approach needs to develop special forms and methods of training, adapted to the level of development of the professional environment of IT professionals.

1. Introduction
Training of labour market-viable specialists requires arranging an educational process taking into account the next features [1]:

- Enterprises require qualified graduates who have to be prepared to start on their jobs right after graduation.
- Field of information technologies is changing rapidly, new technologies are developing continually.
- Forms and methods of training adjust to a rapidly changing informational educational environment.

Teachers have to update constantly the educational content to ensure proper quality of modern professional training. They use various approaches, such as re-processing and periodic re-issue of study books and manuals, development of electronic educational resources based on specialized systems and web-resources, use of professional software products, including those available on the Internet, development of their own software-environments for teaching, including these based on mobile technologies. At the same time, forms and methods of teaching have to correspond to educational content of disciplines.

This paper presents studying the enterprise infocommunication infrastructure and its management features within a framework of the traditional educational process of a university.

The authors were directed by demands of the Federal State Educational Standards of higher education in the field of training (bachelor) 09.03.01 Informatics and computer technology, 09.03.02 Information systems and technologies, 09.03.03 Applied Informatics in organization of educational process.
2. Studying the enterprise infocommunication infrastructure

Information technologies at enterprises are required to provide users with information system services, whose work is supported by the enterprise infocommunication infrastructure.

Problems of IT-resources management and IT-services effectiveness improvement (ITSM - Information Technology Service Management) were formulated in the 1980s. This methodology has been highly demanded since the beginning of this century, with the transition from the traditional model - support of enterprises’ informational and communicational infrastructure - to the model oriented to servicing core business of an enterprise. On enterprises departments (IT-departments), providing functional departments with various services related to information technologies, were formed. Additionally to operational services provided to functional departments of an enterprise to ensure proper functioning of its IT-systems, IT-departments have work to improve their own efficiency level.

At the present time, enterprises require use of information technologies in such areas as: automating of inner business-processes, supporting interactions with partners, maintaining of electronic correspondence flow, use of the Internet, etc. Initially, IT-departments at enterprises were focused on functions related to information technologies. The existing earlier “resource”-approach to IT-department management was based on the idea that the IT-departments’ task was creation and support of various systems, considered as resources. Based on this approach, IT-department creates and maintains a set of resources, processes complaints and requests of employees.

Modern IT-departments have a service-oriented structure, which is built as a system of processes managing services. Figure 1 shows connections between IT-department and functional departments [2].

![Figure 1. Connections between IT-department and functional departments are build up as “provider – consumer” connections](image)

Management of IT-department built the way that it can provide high-quality services and efficient business solutions for an enterprise. IT-department provides services to functional departments and connections between them built based on a model ”provider – consumer”. IT-departments support and develop infrastructure according to requested services and specified quality. Functional department sets its requirements for a specified type of required services and their quality. In this connection, IT-department of an enterprise becomes an important resource for an enterprise management system.

Table 1 shows the management levels hierarchy of an enterprise and management functions at each of these levels.

Every level is designed to perform specific management functions. Each hierarchical management level has its own computing environment, which is a network generally. Information networks with their
functioning characteristics are formed at every management level. Let us review studying features of office networks, corresponding to upper and middle levels of corporate management system hierarchy.

Table 1. Hierarchy of enterprise management levels

| Management system levels               | Basic management functions                                      |
|----------------------------------------|-----------------------------------------------------------------|
| Financial and economic activity        | Financial planning                                              |
| management                             | Customer relationship management                                 |
|                                        | Supply chain management                                         |
|                                        | Human resources, etc.                                            |
| Management of production activities    | Operational planning                                            |
|                                        | Quality management                                              |
|                                        | Order deadlines control                                         |
|                                        | Productivity control, etc.                                       |
| Manufacture management                 | Technological processes management                              |
| Management of industrial controllers   | Production processes management                                  |
|                                        | Collection and processing of data                               |
| Sensory level                          | Scanning of sensors                                             |
|                                        | Operating actuators management                                   |

3. Educational content and educational student activity when studying enterprise infocommunication infrastructure

Under the training of IT-professionals, management of an information network infrastructure has to be taken into account. Information technologies systems are getting more complicated and require creation of information technology service management systems.

Every type of the enterprise infocommunication infrastructure defines an educational content of IT-students. For example, when students study disciplines corresponding to network infrastructure of information systems, first they need to study basic knowledge, which can contain the following topics:

1. Definition of distributed processing. Possible structures of distributed information processing systems.
2. Basic concepts and definitions of information (computing) networks, such as: network architecture, network protocols and interfaces, a concept of "open systems", international standards for network interactions implementation, an OSI / ISO model, “client-server” technology etc.
3. Basic modern network technologies of local and corporate networks for office use, based on cable and wireless connections, namely: standards for these technologies, possible data communication environments, access methods to data communication environments, the coding methods of signals and data, interface with the data communication environments.
4. Basic information about network interactions and network services, particularly: networks interaction organization, network interfaces and protocols, network services, addressing in networks etc.
5. Modern technologies of enterprise management, based on the life cycle of wares, service-oriented business processes.
6. The models of the life cycle of the information systems, planning of functional subsystems of enterprise systems. Planning technologies, methods, facilities, stages of planning, estimation of the information system efficiency and quality, spared technologies.
A possible form of educational activity is a training based on a specially organized training ground. Particularly, such training ground was organized for students of bachelor programs 09.03.01 Informatics and computer technology, 09.03.02 Information systems and technologies, 09.03.03 Applied Informatics in the following disciplines: "Infocommunication systems and networks", "Network technologies" and "Enterprise information systems".

A hierarchical structure of the enterprise management system of a manufacturing enterprise has to be taken into account while building a training system, which has production character of activity. Students perform necessary operations to create local network infrastructure, using provided to them computers. Modern infocommunication infrastructure of an enterprise is integrated and formed by a combination of cable and wireless components. Students consistently create separate fragments of the local network, installing cable systems, computers and communication equipment, making necessary adjustments and tests of single elements of the infocommunication system and networks. Under forming cable network segments, the focus is on the studying of various modifications of Ethernet technology, which has become widespread in office networks. Fragments of wireless networks are built on the basis of technologies that meet the standards of the IEEE 802.11 series.

When studying the methods of creating a cable infrastructure of enterprises, students are introduced to the principles of building a structured cabling system (SCS), which are set out in ISO / IEC IS 11801, CENELEC EN50173, EIA / TIA-568A and ANSI / EIA / TIA 569. Among the currently recognized principles, the following can be considered: structured (decomposition of subsystems), universality (compliance of all solutions with standards), redundancy of all components, a zone (decomposition in horizontal subsystems of consolidation zones of workplaces). Implementing wireless local networks, enterprises are guided by the network structures: peer-to-peer (Ad-hoc), with an access point and multi-cell. Students familiarize themselves with all such structures by working on the network computers.

The penetration of mobile devices into a production area leads to the integration of office information networks of enterprises with wireless networks (WLAN). The integration of enterprise information networks creates the need for unifying the network infrastructure, the network managing, increasing the security and confidentiality of the network. It introduces certain difficulties in organizing the safe operation of enterprise information systems. Using mobile devices increases the load on existing WLANs. The access points of the network should be adapted to changes in the location of mobile devices. Stable performance is required in such complex multi-user environment. These features of the functioning of networks should be mastered by students.

After mastering basics of installation, adjustment and testing of infocommunication infrastructure, students move on to learning of administration basics. For solution of this problem they use virtual environments. Each student creates on PC a virtual environment which usually includes a server that has a special role in learning environment and one (or more if necessary) network workstation. Student learns in created virtual environment and getting necessary skills in setting up various network services required for a normal functioning of enterprise information systems. Among these services, there are: DNS, Dynamic Host Configuration Protocol (DHCP), terminal management.

After mastering deployment skills of basic network services of an enterprise, students begin to administrate more complex services in terms of their formation and configuration parameters (for example, based on the PowerShell system). During operations implementation of the network and information systems administration, students master skills of creating terminal access, organizing secure data transmission tunnels, creating hidden file streams, creating directory services (for example, Active Directory) and solving other tasks of managing the enterprise infrastructure.

4. Conclusion

Modern enterprises have a complex of the constantly developing infocommunication infrastructure. Professional activity in such infrastructure requires modern specialists to own network technologies and corporate information systems. One of the educational approaches to the training of such specialists is teaching several disciplines within the curriculum on the interdisciplinary basis.
Such approach needs to develop necessary educational content and new forms and methods of training, adapted to the level of development of the professional environment of IT professionals. The educational content of disciplines should being updated continuously together with continuous development of the information and educational environment of educational institutions.

In the teaching of disciplines "Infocommunication systems and networks", "Network technologies" and "Enterprise information systems", the authors developed the interdisciplinary educational content. It includes consideration of the basics of a wide range of technologies aimed at application in the infocommunication infrastructure of enterprises, and the perspectives for the development of such technologies. On this basis, forms and methods of teaching were used, corresponding to the current level of development of enterprise infocommunications.

References
[1] Eminov F and Golitsyna I 2017 Proceedings of the 14th International Conference on Cognition and Exploratory Learning in the Digital Age (CELEDA 2017) pp. 273-276
[2] Eminov F I 2015 Information technologies of enterprises management (Master Line, Kazan, Russia)