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PROBLEMS OF INFRASTRUCTURE FUNCTIONING OF THE ELECTRONIC DIGITAL SIGNATURE IN UKRAINE

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ПРОБЛЕМИ ФУНКЦІОНУВАННЯ ІНФРАСТРУКТУРИ ЕЛЕКТРОННОГО ЦИФРОВОГО ПІДПИСУ В УКРАЇНІ

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ПРОБЛЕМЫ ФУНКЦИОНИРОВАНИЯ ИНФРАСТРУКТУРЫ ЭЛЕКТРОННОЙ ЦИФРОВОЙ ПОДПИСИ В УКРАИНЕ

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Abstract. One of the key aspects for forming the information society and universal access to network resources is information security as the most important condition of documents and information transmission by means of information and communication technologies. The most reliable and convenient means of data security for the network communication is the electronic digital signature (EDS). The existing conditions of the electronic digital signature are considered and problems of its infrastructure functioning in Ukraine are investigated in this article. Technological problems are currently the most essential. The procedures of obtaining the electronic digital signature and its properties, as well as advantages of electronic digital document flow, are analysed. The necessity to form the infrastructure of the EDS has appeared due to the significant amount of advantages of the EDS introduction. In addition, there is the necessity to regulate and control functioning of the corresponding system by certification. The national EDS system as the cohesive organizational and technical system integrates the corresponding certificates of open keys, means of the EDS (cryptographic transformations), the key certification centers (KCC) and owners of certificates into a single structure and guarantees the quality of EDS services on behalf of the state. The existing conditions of the EDS infrastructure operating are considered which have to correspond to the modern conditions for ensuring effective services of the electronic digital signature and without difficulties and problems for obtaining the certificate of a key. The external and internal factors influencing the low rates of EDS development in Ukraine are enumerated. The main problems of the EDS infrastructure creation and their decisions have been formulated. The solution of problems of the EDS infrastructure functioning in Ukraine will promote the conditions for using all opportunities of the infrastructure, its standardization and development of electronic services.

Key words: digital signature, key, infrastructure, electronic document flow, functional problems.

Анотація. Одним із ключових аспектів формування інформаційного суспільства і повсюдного доступу до мережевих ресурсів є забезпечення інформаційної безпеки як найважливішої умови передачі документів й інформації за допомогою інформаційно-комунікаційних технологій. Найбільш надійним і зручним засобом захисту даних при мережевому обміні є електронний цифровий підпис (ЕЦП). У статті розглянуто існуючий стан використання електронного цифрового підпису, досліджено проблеми функціонування його інфраструктури в Україні. Найбільш істотними на сьогоднішній день є технологічні проблеми. Проаналізовано процедуру отримання електронного цифрового підпису та його властивості, а також переваги використання електронного цифрового документообігу. У зв'язку з наявністю значної кількості переваг впровадження ЕЦП, а також необхідності державного регулювання та контролю за функціонуванням відповідної системи шляхом сертифікації, з'явилася необхідність формування інфраструктури ЕЦП. Національна система ЕЦП як з'єднана організаційно-технічна система інтегрує відповідні сертифікати відкритих ключів, засоби ЕЦП (криптографічних перетворень), центри сертифікації ключів (ЦСК) та власників сертифікатів в єдину структуру і гарантує від імені держави якість послуг ЕЦП. Розглянуто існуючі умови функціонування інфраструктури ЕЦП, яка повинна відповідати сучасним умовам для забезпечення ефективного використання послуг електронного цифрового підпису та не створювати труднощів і проблем в отриманні сертифіката ключа. Виділено зовнішні і внутрішні фактори, які впливають на низькі темпи розвитку ЕЦП в Україні. Сформульовано основні проблеми побудови інфраструктури ЕЦП та їх вирішення. Вирішення проблем функціонування інфраструктури електронного цифрового підпису в Україні буде сприяти створенню умов використання всіх можливостей інфраструктури, її стандартизації та розвитку електронних послуг.

Ключові слова: електронний цифровий підпис, ключ, інфраструктура, електронний документообіг, проблеми функціонування.

Аннотация. Одним из ключевых аспектов формирования информационного общества и повсеместного доступа к сетевым ресурсам является обеспечение информационной безопасности как важнейшего условия передачи документов и информации при помощи информационно-коммуникационных технологий. Наиболее надежным и удобным средством защиты данных при сетевом обмене является электронная цифровая подпись (ЭЦП). В статье рассмотрено существующее состояние использования электронной цифровой подписи, исследованы проблемы функционирования ее инфраструктуры в Украине. Наиболее существенными на сегодняшний день являются технологические проблемы. Проанализирована процедура получения электронной цифровой подписи и ее свойства, а также преимущества использования электронного цифрового документооборота. В связи с наличием значительного количества преимуществ внедрения ЭЦП, а также необходимости государственного регулирования и контроля за функционированием соответствующей системы путем сертификации, появилась необходимость формирования инфраструктуры ЭЦП. Национальная система ЭЦП как сплоченная организационно-техническая система интегрирует соответствующие сертификаты открытых ключей, средства ЭЦП (криптографических преобразований), центры сертификации ключей (ЦСК) и владельцев сертификатов в единую структуру и гарантирует от имени государства качество услуг ЭЦП. Рассмотрены существующие условия функционирования инфраструктуры ЭЦП, которая должна соответствовать современным условиям для обеспечения эффективного использования услуг электронной цифровой подписи и не создавать трудностей и проблем в получении сертификата ключа. Выделены внешние и внутренние факторы, влияющие на низке темпы развития ЭЦП в Украине. Сформулированы основные проблемы построения инфраструктуры ЭЦП и их решение. Решение проблем функционирования инфраструктуры электронной цифровой подписи в Украине будет способствовать созданию условий использования всех возможностей инфраструктуры, ее стандартизации и развития электронных услуг.

Ключевые слова: электронная цифровая подпись, ключ, инфраструктура, электронный документооборот, проблемы функционирования.

Formulation of the problem. The most important priority of Ukraine in the current conditions of globalization is information society development with defined basic provisions in line with the various state and international normative and legal acts. In the Law of Ukraine "About the basic principles of information society development in Ukraine" [1], it is recorded that the information society is focused on the interests of people. It is open for everyone and directed to form the innovative model of hi-tech society development where each citizen has the opportunities to create and accumulate information and knowledge, to have free access to them, to use and exchange them in order to give the chance to each person fully to realize the potential for ensuring personal and social development and improvement of quality of life. At the 70th session of the

United Nations General Assembly [2], the priority for increased essential access of the population to information and communication technologies for ensuring the general and inexpensive access both to the Internet and to numerous resources was formulated and accepted

One of the key aspects for forming the information society and universal access to the network resources is information security. This is the most important condition of document and information transmission by means of information and communication technologies. As far as data transfer, the most reliable and convenient security feature of data in a network exchange is the digital signature (DS). At the same time there are a number of problems dealing with the EDS implementation – social and economic, technological, geopolitical and others. Currently, technological problems are the most essential. However, for their solution, it is not enough to change the normative and legal basis or political willpower. Systemic, cardinal changes of the technological basis are necessary at all levels of the EDS project implementation – at the state level (formation and enhancements of the appropriate infrastructure), as well as ultimate users (technical capability of the EDS application). Existence of these problems significantly hinders the EDS development as well as information society formation in general. In this regard, the task of problems systematization is relevant and the most characteristic for the EDS implementation with the subsequent approaches and mechanisms formation of the selected problems solution.

Analysis of the latest research and publications. Worldwide there is a wide experience of means of the EDS development and the positive results in all spheres of its application. Therefore, many works of domestic scientists and researchers in different systems of society are devoted to the practical research about the development of EDS national infrastructures. Works of scientists devoted to the research of questions about the theory and practice of the analysis, synthesis and application of the EDS are manifold [3-6]. In these works, technological and legal aspects of the EDS implementation have been investigated and ways of the appropriate infrastructure formation have been offered. However, there is no scientific research devoted to the EDS infrastructure functioning in Ukraine which would decide not only application-oriented and legal issues but also would create the fundamental scientific and methodical platform for the further EDS development as a component of the complex of information society development. The most powerful problems of the EDS infrastructure formation, their correlation with nation-wide or regional social and economic problems have not yet been systematized. It is partly connected to the novelty of the problematics for domestic science and practice. But, considering the importance of the integration of Ukraine into the European Union, the question of the electronic space formation and the EDS infrastructure development acquires special relevance.

Based on the above, the **purpose** of this article is to study problems of the electronic digital signature infrastructure functioning in Ukraine and separate perspectives of its development.

Results. When electronic documents are used and they are transmitted on telecommunication channels, it is very important to consider information security carefully. For this reason, all usual electronic documents are not protected from change or unauthorized access to the information.

Today, the security of the electronic document is carried out by applying an electronic digital signature (EDS). The electronic digital signature is a type of the digital signature received as a result of cryptographic transformation of the electronic data which is added to this set, or logically unites with it and gives the ability to confirm its integrity and to identify the person who signs the document [7]. When the electronic digital signature is applied, any electronic document accepts the status of the original and imbues it with full validity. Within an analog of the autographic signature for providing validity to the electronic document, the electronic digital signature can be used by all legal entities and individuals. The validity of such an electronic document, signed with the EDS, can be equivalent to validity of the similar paper document with the autographic signature of the capable person and his stamp.

The EDS has all main properties which correspond to the autographic signature of the person [7]:

– the electronic digital signature demonstrates that the received document was received from the person who signed it;

– it guarantees protection against distortion and rectifications as well as integrity in the signed original document; and

– it demonstrates impossibility to refuse obligations of the person who signed the document.

Before compiling the electronic document, a block of data is added which is called the EDS. Therefore, safe and lawful use of the EDS, almost importantly, is based on all means which can be used for work with the EDS. These means pass independent examination and certification in the public service of special communication and information security of Ukraine.

All procedures of the EDS formation which are legal can be divided into two basic stages:

1. By means of program information support and special mathematical function "the message print" is calculated and it has the following important features:

– the invariable fixed length which is a constant, irrespective of the information volume of the whole document;

– features of a unique print for each document; and

– the impossibility to restore the document on its printing.

It is necessary to note that if the document was slightly modified, then, certainly, its digital fingerprint will be changed and revealed in case of control verification of the electronic digital signature. It does not give the ability for modifications of the electronic document created and signed with the EDS.

2. The digital fingerprint of the document is ciphered by means of the software and personal private key of the author of the created document. Electronic computation of a print of the paper document protects it from modification by any strangers after signing, and its encoding by the closed personal key confirms copyright of the electronic document.

For implementation of the described procedure the appropriate infrastructure is created which has the following structure (Fig. 1) [8].

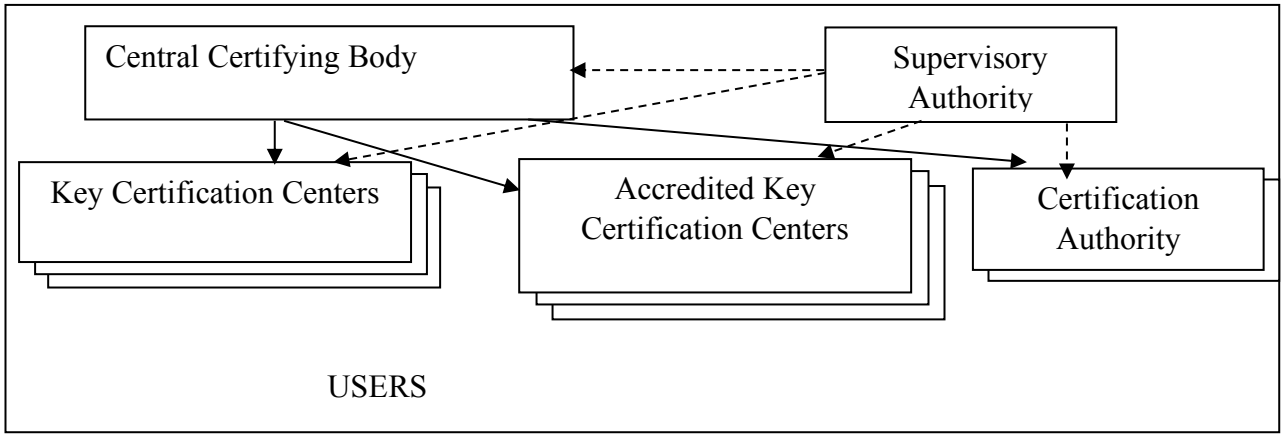

Figure 1 – EDS Infrastructure in Ukraine

The analysis of legal and technical bases of the EDS functioning gives the chance to formulate primary benefits for its using in a business environment:

– transition to legal paperless document flow that allows the user to save temporal and reverse resources significantly;

– authentication, integrity, confidentiality and irrefutability of training, submission/delivery, account and document storage, enhancement of the procedure;

– cryptography information security (of electronic documents) by transmission through open channels that leads to minimization of risks increasing confidentiality of information exchange of documents;

– possibility of fast search and viewing of electronic documents in the EDS allows to reduce time passing of different organizational and legal procedures, design and submission of different reporting;

– reduction of a corruption component and support of transparency of public authorities functioning for their using exclusively public keys;

– independence of geographical factors allows to expand significantly business boundaries, contributes to the development of the international economic relations and formation of information society in general.

The necessity to form the infrastructure of EDS has appeared due to the significant amount of advantages of the introduction of EDS, as well as the necessity to regulate and control the functioning of the corresponding system by certification. Therefore, currently the whole national EDS system, as the cohesive organizational and technical system, integrates the corresponding certificates of open keys, means of the EDS (cryptographic transformations), the key certification centers (KCC) and owners of certificates into a single structure and guarantees the quality of EDS services on behalf of the state.

We will illustrate the place and value of each element in the electronic digital signature infrastructure in more detail. The quality of EDS services is regulated by the Central Certifying Body (CCB) which is a body of accreditation and state supervision of activity of the key certification centers [6]. As for the CCB, it holds accreditation of the specialized centers of open keys certification. It forms and issues certificates of open keys for all certification centers and the centers of electronic keys certification. The CCB blocks, restores and cancels the enhanced certificates of open keys. It keeps electronic registers of the cancelled and blocked existing enhanced certificates of open keys. As well, the CCB provides round-the-clock access to the appropriate electronic registers by references of public telecommunication channels. Performance of the CCB functions has been assigned to the Ministry of Justice in Ukraine. Technical and technological support of the CCB functions performance is carried out by the state enterprise "Information Center" of the Ministry of Justice in Ukraine which is defined by the administrator of the CCB information and telecommunication system. The functions and tasks of the central body has been analysed by the department of special communication and information security of the Security Service in Ukraine as the sphere for applying the electronic digital signature services with defined rights and duties in the Law of Ukraine "About the electronic digital signature" [7].

According to the State agency concerning electronic control of Ukraine [9], the EDS is used by no more than 6 – 7% of the population. Moreover, the most of users are public workers who received the EDS for compilation and submission of their own mandatory electronic income statement. At the same time, in the European countries, use is about 90 – 95 %, and in other developed countries (for example, Australia) the number of users – non-public service persons – is more than 35%, and public service employees – more than 90 %.

The situation with the low development, use, and distribution of EDS in Ukraine is connected, first of all, to the low digital readiness of the country. According to the report "Measurement of information society" of the International Telecommunication Union (ITU) of the UNO [10], Ukraine is in 68th place (out of 157) in the world in the development of ICT. This index consists of three measures:

– access to ICT (the number of the fixed phones per 100 families, mobile phones per 100 inhabitants, the capacity of external channels per 1 Internet user, the number of computers per 100 people, the number of Internet Users per 100 persons);

– use of ICT (the number of personal computers, the fixed broadband access per 100 inhabitants, mobile broadband access per 100 inhabitants); and

– habits of using ICT.

According to the statistical data [11], rates of development of key indicators, defining digital readiness, though they have positive dynamics, are characterized by considerable variation and an imbalance of development (Table 1).

Table 1 – Dynamics of some indicators development of digital readiness

Indices	At the beginning of 2017	At the beginning of 2016	At the beginning of 2015	At the beginning of 2014	Dynamics
Urban subscribers of fixed communication, thousand	7514,4	7715,5	8863,7	10010,2	0,75
Rural subscribers of fixed communication, thousand	930,8	1058,2	1260,4	1418,3	0,65
Subscribers of mobile communication, thousand	56717,9	56927,9	59352,3	62458,8	0,91
Subscribers of Internet, thousand	6723,0	6525,1	6001,9	5957,4	1,13

Resource: data of Goskomstat of Ukraine

The data from Table 1 demonstrate that only the number of Internet users is increasing increases in all indicators. The variation of telephone installation in cities and villages is also distinctly highlightled. The enterprises of Ukraine are equipped with information communication technologies with Internet access for 95,2%. At the same time, only a little more than 36% of households have personal computers. Moreover, nearly a half of the population has no constant access to the Internet. It is partly connected with the low standard of living, rise in unemployment, continuous increase in prices for products of prime necessity, as well as public utilities that reduce the ability of the population to use ICT services (Table 2).

As shown in Table 2, the share of the working population is decreasing, and the real wage has no stable dynamic, which causes economic instability of the population.

There is a negative fact that the share of income from providing ICT services makes up only 1,61% of GDP, and the general level of electronic readiness for information society development does not exceed 50% (according to the data [9]).

It is possible to claim that the low level of ICT development is the main reason for difficulties with the EDS development. For this reason, further development of the electronic digital signature infrastructure has to be based on technological and technical conditions of ICT development.

Table 2 – Some indicators of the standard of living of the population

Indices	At the beginning of 2014	At the beginning of 2015	At the beginning of 2016	At the beginning of 2017
Share of economically active working-age population, %	73,1	71,4	71,5	71,1
The nominal average salary, UAH per month.	3282	3480	4195	5183
Dynamics of the real wage, %	+8,2	-6,5	-21,2	+9

Resource: data of Goskomstat of Ukraine

The analysis performed was allowed to select external and internal factors influencing low rates of the EDS development in Ukraine. It is possible to define such external factors as:

– low digital readiness of the country;

– rather low level of computerization of the population during essential variation between the city and the village;

– the decrease in economic activity of the population and the enterprises influencing demand for the EDS; and

– vital issues with implementation of the program for providing the population with biometric passports and ID cards, etc.

In our opinion, it is possible to define such internal factors as:

– imperfect legislation and difficulties with KCC registration;

– problems with maintaining electronic registers and services of key certificates;

– imposition of the EDS application by public authorities and their employees; and

– difficulties with ensuring cryptographic information security, the necessity for carrying out certification of complex systems of information security and others.

It should also be noted that currently only Accredited Key Certification Centers (AKCC) deal with issue of keys to the EDS. There are about thirty such centers in the country. Such insignificant system development of key issuance significantly complicates their distribution, especially in rural areas, and demands development of this structure.

Considering all reasons, the provided data [1], as well as the previous research of authors [12], the main problems of creation of the EDS infrastructure have been formulated, namely:

– the low level of ICT development, variation and a digital division between the city and the village as well as between some regions and spheres of economic activity;

– the low level of the population solvency leading to unsatisfactory indicators of households with personal means of access to ICT;

– the low efficiency for using the financial, material, personnel resources directed to informatization, low level ICT introduction to the social and economic sphere, in particular in agriculture;

– the poor development of electronic business, use of non-cash payments;

– the level of computer and information literacy of the population is insufficient, as well as the level of information representation of Ukraine in the Internet space;

– the vital issues with development and introduction of new training methods using modern ICT, it is caused by both financial and personnel problems of educational institutions;

– the level of the state support for producing means of informatization, software and ICT introduction is insufficient that doesn't provide all requirements of economy and public life;

– the risks connected with possible information leakage, cyber crime, industrial espionage, etc.; and

– the shortage of KCC.

Each of the listed problems needs a deep, all-round analysis and decision. In our opinion, it is necessary to solve these problems and we propose the following:

1. A network development of centers providing the EDS services, i.e., the creation of the KCC developed network. During creation of this network it is necessary to consider financial and economic, as well as organizational components. Among the main components, it is possible to select: expenditures for creation of potential infrastructure, placement and its equipment, purchase of the software, carrying out engineering and technical operations, certification, state certification examination, certification of all technical means, vocational education of service personnel, availability of an extensive network, etc. Under these circumstances, the network creation of the organizations offered in this article which would have functions of the Central Certifying Body (CCB). These organizations could work on a contractual basis between the state and different bodies (for example, notary offices, the mail enterprises, banks). The essence of the contract consists of the certification body acquiring the right from KCC for the appropriate services within the primary activity. Thus, the solution of the question for the EDS keys providing is possible both in the city and in rural areas.

2. Formation of technical capabilities using the EDS by means of mobile devices. This direction is relevant, first of all, because the density of mobile telephony exceeds an index of 130%, i.e. practically each citizen has a mobile device. For the EDS development on the basis of the Mobile ID system (the EDS on the SIM card), it is necessary to form information support and creation of the simplest mobile applications in use and the interface in order to install and use this

system. The necessity of the interface simplicity is caused by low digital literacy on the part of the population.

3. The solution of the question with enhancement of basic training methods for using ICT technologies at all stages of education. This is because in Ukraine, the issuance of internal ID-passports with the built-in electronic digital signature is planned to begin in the middle of 2018.

Therefore, it is necessary to consider that development of the EDS infrastructure – not as an end in itself, but as a part of complex measures for formation and implementation of the electronic government, as well as a transition of the country to information society. Questions for overcoming problems of the EDS infrastructure development are a part of the general mechanism of the information society creation oriented to its citizens and based on the ICT platforms. This mechanism is reflected in Fig. 2.

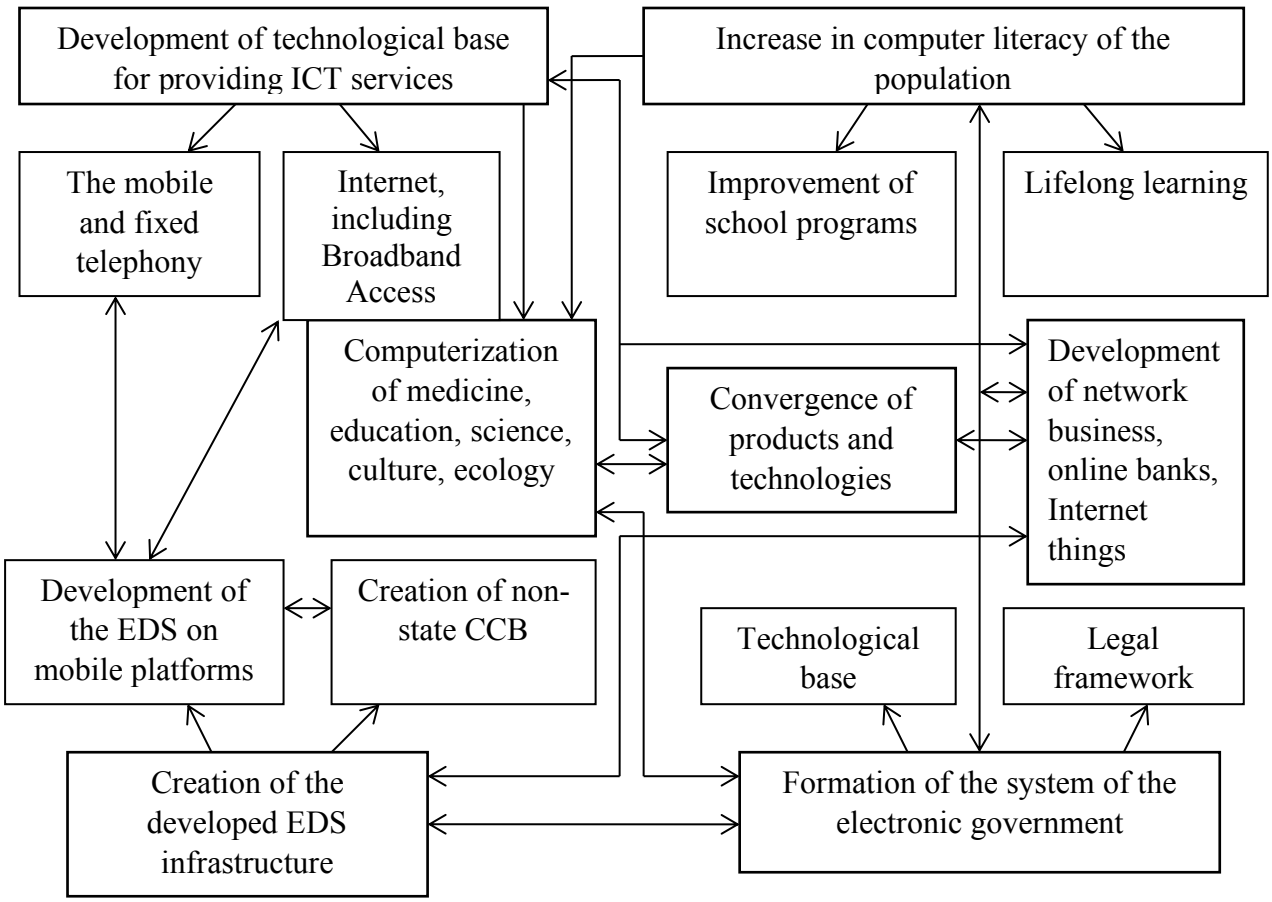

Figure 2 – Components of the mechanism of the EDS infrastructure development as a part of information society creation

In our opinion, the solution of problems of the EDS infrastructure functioning will promote:

– ensuring development of cross-border cooperation and integration of Ukraine into the world electronic information space;

– recognizing the foreign qualified certificates of open keys and the qualified digital signature in Ukraine;

– recognizing the legal importance of the received qualified electronic confidential services and ensuring due trust of natural and legal entities to such services;

– effective electronic managing, including providing administrative services in electronic forms; and

– further developing electronic legal proceedings, electronic procurement, electronic archive and so forth.

As a result of the research of the problems of the EDS infrastructure functioning in Ukraine, it is possible to conclude that there are positive developments in the direction of improvement of the electronic digital signature application. The infrastructure of the EDS has to correspond to modern conditions for ensuring effective use of the EDS services and not create difficulties and problems in obtaining the key certificate. Considerable reduction in the volumes of paper document flow by organizations provides essential advantages in comparison with costs of introduction of new processes for using the EDS. The solution of problems of the EDS infrastructure functioning contributes to the development not only in the areas of electronic business (e-Health, e-Transport, e-Commerce, e-Government, e-Invoicing, e-Procurement), but also in the support of all functions of information society.

Prospects for further research in this direction can be the study of the information risks during the EDS infrastructure functioning that will allow the effective development of services in this area.

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