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## Cloud computing concept in Ukraine: a study of innovative development

**Abstract**

This article explores the main aspects of the cloud computing paradigm in Ukraine. The authors identify the main problems of the cloud computing market in Ukraine and options for their solutions by implementing an innovative concept of the public cloud platform. The authors of the article have researched the cloud computing market in Ukraine, the role of the state in developing the abovementioned market and building innovative public cloud platform as a centralised data center which will enable the state to provide all public services and innovative services.

The main idea of the concept of building an innovation public platform is the creation of a hybrid cloud which will integrate suppliers and consumers of information products and services, investors in the IT sector and mechanisms for sharing and protecting of information.

The study shows that the concept of cloud computing is not only technological innovation in IT, but also a way to create new business models, when small manufacturers of IT products, including in the regions, have an opportunity to quickly offer the market their services and realise their business ideas. Public support for cloud computing, along with investments in young companies throughout the country, will quickly create an ecosystem of innovative productions.

The implementation of the concept of a state-owned innovative cloud platform is a legitimate step towards the development of the ICT industry and an innovative economy in Ukraine.

**Keywords:** Cloud Computing; Virtualisation; Service: Infrastructure: Innovation; Concept development

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**Дослідження інноваційного розвитку концепції хмарних обчислень в Україні**

**Анотація.** У статті досліджено основні аспекти розвитку хмарних обчислень в Україні. Автори визначили головні проблеми ринку хмарних обчислень в Україні та варіанти їх вирішення шляхом реалізації концепції державної інноваційної хмарної платформи.

**Ключові слова:** хмарні обчислення; віртуалізація; сервіс; інфраструктура; інновації; концепція розвитку.

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**Исследование инновационного развития концепции облачных вычислений в Украине**

**Аннотация.** В статье исследованы основные аспекты развития облачных вычислений в Украине. Авторы определили главные проблемы рынка облачных вычислений в Украине и варианты их решения путем реализации концепции государственной инновационной облачной платформы.

**Ключевые слова:** облачные вычисления; виртуализация; сервис; инфраструктура; инновации; концепция развития.

**1. Introduction**

Over the past few years, the concept of cloud computing has come into force and become popular in the field of information technology. Many organisations have begun to implement these new technologies in order to reduce costs expenses and administration time by improving virtualisation of machines. As practice shows, cloud technologies are efficient and quite reliable even to provide services to public authorities of the most developed nations. A similar trend is observed in all countries in Eastern Europe and the EU, where the use of cloud computing has become the *de facto* standard in many areas of socio-economic relations. The paradigm of cloud computing has potential that can provide a technological leap to a qualitatively new state of the domestic IT industry, which is very important for the Ukrainian economy. This is what determines the relevance of the study of the concept of cloud computing in Ukraine.

**2. Brief Literature Review**

Every year, the number of studies in the field of cloud computing and technologies increases. Mostly scientists are involved in the consideration for implementing cloud technologies in modern education system, including domestic and foreign scientists, among whom are José A. González-Martínez [1], Fernando Koch [2], O. G. Glazunova [3], O. O. Gribyuk [4], M. P. Shishkina [5], R. Kaur & S Singh [6]. R. I. Meneguet studied the relevant issue in terms of transport [7], while J. A. Banares [8], S. M. Doguchaeva [9], M. Armbrust, A. Fox, R. Griffith, A. D. Joseph [10], F. Etro [11] conducted economic research. The relevance of the need to create regional cloud infrastructures for executive authorities is raised by scientists such as M. Metheny [12], O. S. Lobanov, V. F. Minakov, [13].

In domestic scientific literature, there are no developments on solving the task of deploying the Ukrainian cloud information space and the role of the public sector in the development of cloud services remains unexplored. Today's relevant task is to find innovative mechanisms and models of domestic cloud deployment.

**3. The purpose** of this article is to study the cloud computing market in Ukraine, as well as the role of the state in developing the abovementioned market and building innovative public cloud platform as a centralised data center which will enable the state to provide all public services and innovative services.

**4. Results**

An analysis of the Ukrainian market of information and communication technologies (ICT) has revealed a negative trend. In 2015, revenues from ICT fell to USD 1.4 billion, which is by 44% less than in 2014, and reached the level of 2005 [13]. The only segment of ICT that has shown positive dynamics is cloud services. In 2015, the revenue from cloud services increased by almost 10% compared to 2014 and amounted to USD 9 million.

IT professionals attribute this to the relative stabilisation of the economy, growing interest in cloud services from the part of business and government, and increased cost of services by domestic operators because of the devaluation of the hryvnia [14, 32]. According to forecast data, this trend will continue until 2017, and the segment could reach an index of USD 14.3 million (Figure 1).

The analysis of projects and proposals of cloud operators has shown that the greatest demand is for the following types of cloud services:

- 1) rent of computing capacity on demand (Infrastructure as a Service - IaaS);
- 2) use of applications as a set of services (Platform as a Service - PaaS);
- 3) use of separate software (Software as a Service - SaaS).

Their share in 2015 amounted to 97.2% of all sales, while the share

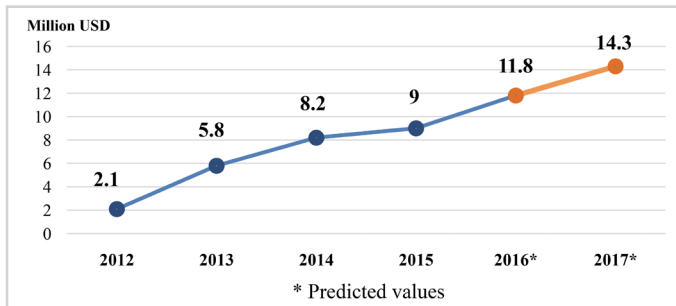


Fig. 1: **Volume of the Ukrainian market of cloud services**  
Source: Compiled by the authors based on [13; 14]

of IaaS was 67%, the share of SaaS equalled 24.8% and the share of PaaS accounted for 5.4% [14, 39]. The remaining 2.8% is for specialized services such as data backup, hosted PBX, CCTV (Closed Circuit Television) security in the cloud and more.

In 2016, the number of Ukrainian enterprises using cloud services in their activity increased by 14%, compared to 2013, and amounted 48% of the total number of economic entities (Figure 2). It should be noted that according to the study by Denovo [13], 96% of companies received a positive effect from the use of clouds in 2016.

Today, the largest consumers of cloud services of all types (IaaS / Paas / SaaS) in Ukraine are different Internet services and commercial banks. Web design and online stores should be noted among the first group.

As for banks, they usually transfer secondary resource-intensive services to the clouds and use cloud-based data centers as back-up areas as testing ground for new services.

The market of cloud services in Ukraine is at an early stage of development, yet it is obvious that in the next five years this segment will grow rapidly and gain leading positions if compared with other areas of ICT. It is expected to continue to actively introduce a variety of SaaS services for the mid-size and small business segments, i.e. programs such as accounting and inventory control, CRM, lightweight version of ERP-systems, as well as corporate email services. As expected, data storage and backup services, use of virtual PBXs, platforms for collaboration on documents, web conferencing tools and time tracking will be in demand. Namely, the mass segment contains the greatest potential for the development of the cloud segment in our country. In addition, significant potential for growth of the market is hidden in organisations and institutions of the public sector and executive bodies.

It should be noted that the rapid development of cloud services, particularly in SaaS, will lead to the deployment of powerful computing infrastructure to provide services for Ukrainian consumers. We believe that the state should get involved in this process and provide construction of such infrastructure by implementing innovative concepts of its own innovative cloud platform.

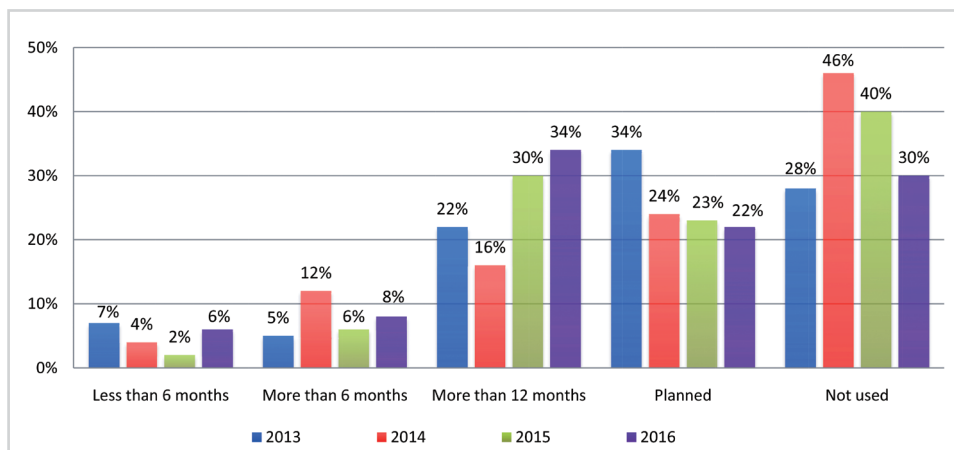


Fig. 2: **Dynamics of using cloud services by Ukrainian enterprises in 2013-2016**  
Source: Compiled by the authors based on [13]

The main idea of the concept of building a state innovation platform is the creation of a hybrid cloud which will integrate suppliers and consumers of information products and services, investors in the IT sector and mechanisms for sharing and protecting information. The implementation of the proposed concept will provide support to local business entities from IT, thus reducing their costs by 10-15% and improving the quality of business processes. Developers and authorised distributors of information products will gain new customers, thereby increasing sales and developing the IT market. It should be noted that the state can simultaneously act as a consumer of its own cloud services. In particular, health care, transportation, housing and other socially important sectors will be able to safely use information products and technologies and will not depend on foreign companies, which are cloud providers that provide services at their own discretion. The development of a centralised public cloud will lead to the development of advanced technologies such as SDN (Software Define Network) and SDDC (Software Define Data Center). Transfer of such services to the software plane will also revive the domestic segment of software development.

Abroad, the public sector is successfully switching to using its own cloud-based services. Thus, the US State Department has clearly demonstrated its goal to become a powerful supplier of cloud services via the cloud service system FAN (Foreign Affairs Network). The state plans to increase its services through FAN by 15% by the end of 2018 [17]. The State of Delaware has transferred 80% of the physical servers of public authorities to a private cloud and cost savings are estimated at about USD 4 million per year [18]. In the UK, the G-Cloud State Cloud Computing Program has been developed, which offers a scenario for the creation of centralised closed cloud infrastructures, which bring together agencies with similar functions. Similar programs are being implemented in Singapore and the EU. However, these programs offer the creation of closed or separate cloud platforms for various government agencies. In contrast, the model proposed by the authors provides for the creation of a unified infrastructure in the form of a system of public data centers, open to commercial customers. The authors believe that this is the most appropriate method of ensuring economically reasonable conditions for the concentration of information resources.

The implementation of the innovative state cloud platform will provide not only additional revenues to the state budget, but also rapid socio-economic development, since the effective functioning of the information component of the state is one of the essential and driving criteria of building an innovative economy.

The structure and relationship components of the innovative public cloud platform are presented in Figure 3 as a graphical model.

The central element of the proposed model is the main business process «Provision of cloud services» and auxiliary business processes «Advertising», «Analytical data processing», «Technical support». Provision of cloud services includes implementation of three service models, which are IaaS/PaaS/SaaS.

The complexity of public institutions will only grow in coming years, as the number of electronic services for the population is growing rapidly. The public cloud platform will save money by eliminating purchases of new software versions, equipment for its deployment, as well as their technical support. Fees for deploying private services based on public platforms also provide additional revenue to the budget. The introduction of the public cloud platform can provide benefits for public authorities and households (see Table 1).

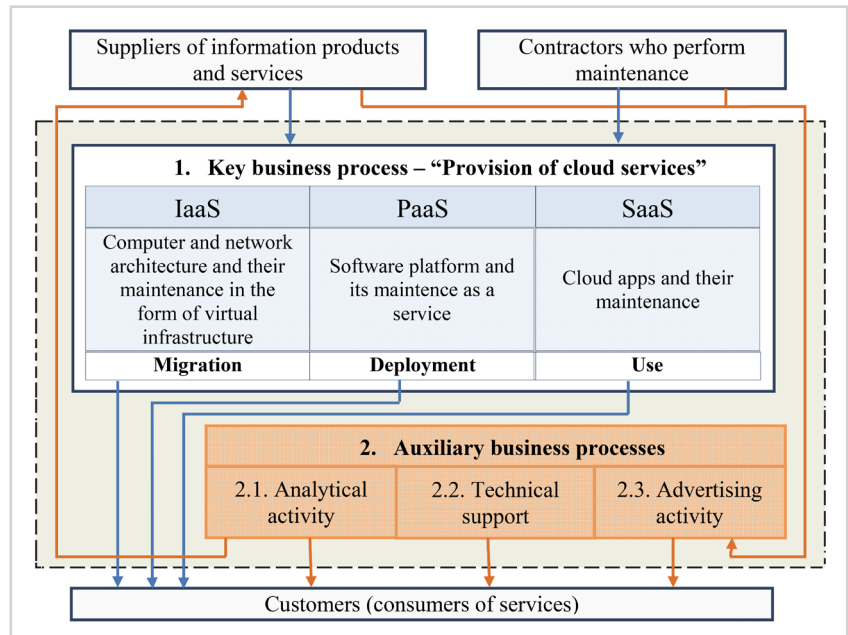


Fig. 3: Graphic model of the structure of the public innovative cloud platform  
Source: Compiled by the authors

The selected model elements are essential for the implementation of effective interaction with suppliers and consumers of cloud information products. For example, the implementation of advertising processes will ensure the advancement of both the innovation platform as a whole, and certain developers and vendors of information products under the agreement with them. The analytical work of the cloud is aimed at detecting and forecasting, both on the basis of own data and market indicators, trends and benchmarks of consumer behaviour and the state of the IT market. These reports can be used for the purposes of the state (optimization of product set and price parameters, implementation of anti-monopoly activities, etc.) and provided to partners and customers on agreed terms.

Analytical and promotional activities are essential for effective collaboration with suppliers and consumers of cloud information products. It is also an additional source of revenue to the state budget.

Technical support is included in the basic list of QoS services (quality of service) and is aimed at a comprehensive improvement of the quality of customer service and maintenance of competitive advantages of the innovative project. This item should include a real-time failover system (proactive monitoring). Making rapid adjustments to existing services in accordance with changes in the legislation is also an essential feature.

The source of information resources of the cloud platform is software vendors and services in the face of domestic and foreign development companies, their official representatives, as well as institutions of education and science.

Customers of the public cloud platform are legal entities and individuals, who are using cloud products or services for personal use or in the course of their business.

Also, the structure of the cloud should provide a support unit represented by various institutions and organisations performing maintenance of the cloud and its support. We believe that it is expedient to involve third parties during the formation and operation of the cloud platform in order to reduce the time of entry into the market.

As a technical solution for the innovative cloud platform, a multifunctional cloud infrastructure model which is based on a distributed cloud data center (CDC) using converged (integrated) architecture, based on cloud computing and SDN (Software Defined Network, program-conditioned data network) can be selected. This model unites geographically distributed state CDC into a virtual platform thanks to active intellectual management and provides well-tuned IT services.

Tab. 1: Evaluation of advantages of the public cloud platform

Advantages	Service models		
	IaaS	PaaS	SaaS
Cost saving	Reduction of budget expenditures on IT equipment	Reduction of budget expenditures on software	Reduction of the cost of the organization for maintenance of software applications
Improvement of the manageability of the IT infrastructure	Optimisation of infrastructure investments	Complex automation of public authorities	Improved service quality
Increased user productivity	Reduced time for incident handling and equipment repair	Access to many services	Reduced time for registration and authorisation
Data analysis	Simplification of monitoring and balancing software and hardware loading	Application of BigData methods for obtaining statistical information for government agencies	Marketing and analytical research for clients
Centralised provision of legal requirements	-	Centralised amendments to the legislation	Rapid changes to the services
Data protection	Reduction of costs to protect software and hardware	Reduction of costs required to develop and implement monitoring services	Reduction of costs to restore service in the case of hacker attacks

Source: Compiled by the authors

Converged (integrated) architecture uses distributed storage, virtual computing, virtual network and cloud management software to integrate computing, network resources and data warehouses. SDN Network is dynamically configurable; SDN enables a high-performance platform providing automated services, which provides automatic network management, unified operation O&M (Operations and Maintenance) and global topology, and outputs traffic to the screen.

It should be noted that cloud services are one of the most effective mechanisms for commercialising innovations in information technology, since the implementation of the proposed concept of innovative public cloud platform offers additional sources of income such as software sales, advertising and analytical activities, managing investments in the IT sector.

The implementation and commercialisation of the innovation platform is a complex and long-lasting process, which can be divided into two main stages of the life cycle: the creation and growth stage and the performance stage.

The first step is to solve the following problems:

- 1) forming a stable partnership relations with suppliers;
- 2) establishing and reliable operation of cloud data centers;
- 3) developing a friendly platform interface;
- 4) forming the optimal set of services;

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5) defining the policy of interaction with consumers (pricing policy, creation of a feedback function, etc.).

At the second stage, constant monitoring of the needs of consumers of products, competitors and suppliers is required. At this stage, the following tasks should be performed:

- 1) formation of the client base, its evaluation and structuring;
- 2) development of a model for setting prices for services according to the client's category;
- 3) marketing and analytical research;
- 4) provision of the after-sales technical support to cloud clients.

## 5. Conclusions

The study shows that the concept of cloud computing is not only technological innovation in IT, but also a way to create new business models, when small manufacturers of IT products,

including in the regions, have an opportunity to quickly offer the market their services and realise their business ideas. Public support for cloud computing, along with investments in young companies throughout the country will quickly create an ecosystem of innovative productions.

According to the authors, the state should become a key consumer of cloud services in Ukraine. The concept proposed by the authors will allow for the creation of a state-owned innovative cloud platform, which will attract more customers from the public sector. Not only will it attract the necessary investment in the development of information technology, but also accelerate the adoption of new standards for IT development and address key issues of the domestic software industry.

Further studies should lead to the development of concepts relevant to building cloud platforms for state-owned banks and the healthcare system. Also, it is required to examine legal aspects of certification for the possibility of placing state information resources on the platforms of commercial cloud providers.

Thus, the implementation of the concept of the state-owned innovative cloud platform is a legitimate step towards the development of the ICT industry and building an innovative economy in Ukraine.

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