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REAL TIME NETWORK PLANNING IN CLOUD

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МЕРЕЖЕВЕ ПЛАНУВАННЯ В РЕЖИМІ РЕАЛЬНОГО ЧАСУ В ХМАРІ

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СЕТЕВОЕ ПЛАНИРОВАНИЕ В РЕЖИМЕ РЕАЛЬНОГО ВРЕМЕНИ В ОБЛАКЕ

A new approach of network planning in real-time mode with built-in simulation modules on the cloud computing basis is proposed in the article. Integration of distributed modeling and forecasting system E-net Modeling System into the cloud is described.
Key words: *network planning, cloud computing, network planning systems in real-time mode, modeling platform.*
Fig.:7. Bibl: 10.

Запропоновано новий підхід до мережевого планування в режимі реального часу разом із вбудованими імітаційними модулями на базі хмарних обчислень. Також представлено інтеграцію системи розподіленого моделювання і прогнозування E-net Modeling System в хмарне середовище.
Ключові слова: *мережеве планування, хмарні обчислення, система мережевого планування в режимі реального часу, платформа моделювання.*
Рис.: 7. Бібл.: 10.

Предложен новый подход к сетевому планированию в режиме реального времени со встроенными имитационными модулями на базе облачных вычислений. Также представлена интеграция системы распределенного моделирования и прогнозирования E-net Modeling System в облачную среду.
Ключевые слова: *сетевое планирование, облачные вычисления, система сетевого планирования в режиме реального времени, платформа моделирования.*
Рис.: 7. Библ.: 10.

Introduction. Nowadays the network planning systems in real-time mode (NPSRT) are becoming increasingly popular. Such systems allow forecasting implementation of the executive work plans of separate and interrelated projects, developed for enterprises, corporations and entire industries, as well as the planning action for ensuring sustainability of plans to the emerging external influences, including in conditions of uncertainty. This fact makes urgent the task of the usage of built-in simulation models that can assess the effectiveness of the plans and check them to perform the specified requirements by time and resources.

In turn, the usage of complex simulation models in real time involves their execution in the distributed computing structures. High Level Architecture (HLA) [1] is the best known among them. Real-Time Infrastructure (RTI) forms the basis of the construction of HLA. It allows combining different models, providing their interaction within a single synthetic environment, which is typical for reactive systems [2]. NPSRT also refers to the latter.

E-net Modeling System (EMS) [3] is one of the realizations that are based on HLA. Powerful formal apparatus of control E-nets and hierarchical aggregate approach are used to create the models in this distributed simulation system. This provide possibility to forecast the execution of the work plan presented in the form of a simulation model. In addition, there is web-interface in the EMS, which provides suitability of remote mode usage.

However, considering the development of the large-scale projects, HLA is not the best decision of the problem, because the resources are used inefficiently, there is no possibility of load balancing, and weak ability to fault tolerance and complex process of model deployment are identified. At the same time, these difficulties can be overcome by using cloud technologies [4].

The aim of the work is to rationale a new approach of designing a universal NPSRT with built-in simulation modules on the cloud computing basis.

Network planning: from ASP to Cloud computing. Until nowadays, network planning systems (NPS) were used via Application Service Provider (ASP). This model of the software usage means that the ASP-provider provides applications (software products, packages) and all the necessary elements of infrastructure and their services for a fixed monthly payment, with client access to applications over the Internet or a virtual private network (VPN, Virtual

Private Network) [5]. In this case, each user has received his own copy of the application, which is performed at the provider server, and not on the customer's own server.
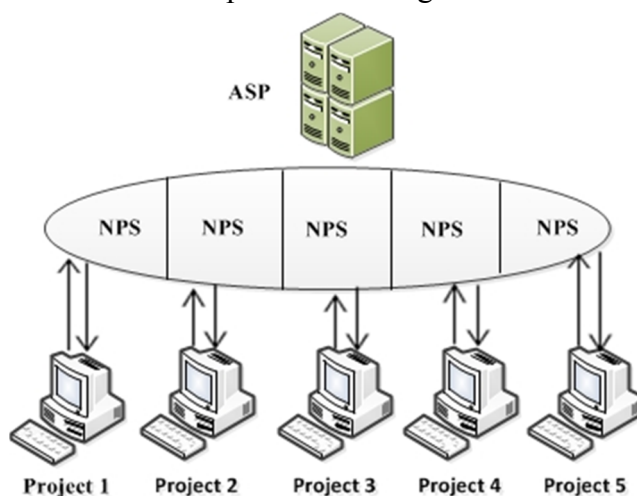
Network planning based on ASP is presented in Fig.1.

Fig. 1. Network planning in ASP

The main components of the ASP model are: companies as service providers, computers, servers, applications, network, and software license. ASP model has positive aspects, related, primarily, with cost savings for the purchase of software, and at the same time a number of disadvantages, and the main is the lack of scalability and complexity of registration lease. Nowadays, due to the development of network and communication capabilities, ASP services are transformed into the model of cloud computing (CC).

Cloud computing is computing, which represents dynamically scalable way of access to external computing resources as a service provided via the Internet [6]. Cloud computing model includes three main components:

- SaaS – software as a service;
- PaaS – platform as a service;
- IaaS – infrastructure as a service.

In fact SaaS is cloud analogue of ASP, other components make the CC model radically different from ASP, providing the possibility of multiple software using by clients without the need of registration of the license in addition to virtualization runtime.

The transformation of network planning services into the components of the CC, indicated above, are considered next.

Network planning and SaaS. SaaS (software as a service) is a business model of selling and usage of the software in which the supplier develops a web application and manage it independently, providing access to software over the Internet for customers. The main advantage of the SaaS model for customer service is the absence of costs associated with installing, upgrading and support of equipment operability and software operating [7].

Also one of the positive aspects of «software as a service» is the absence of the expenditure required to installing, upgrading, and support of servers and related software operability including the purchase of a license for it.

Variant of network planning in the SaaS is presented in Fig. 2.

The usage of cloud computing for network planning provides the following advantages:

- savings on maintenance staff and infrastructure - server virtualization and infrastructure;
- savings hardware resources - it can be greatly simplified with the data processing and storage of information in remote data centers;

– software standardization, even if the enterprise computers have different operating systems (Windows, Linux, MacOS, etc.).

– facilitating access to data for customers and for own employees which could be out of the office, but have the ability to connect via the Internet.
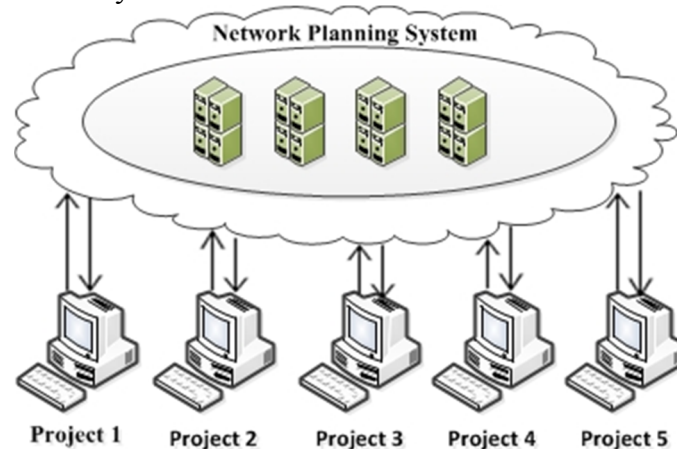

Fig. 2. Network planning in the SaaS

All these advantages allow significantly reducing the cost of processes implementation of planning and control.

PaaS as a modeling platform. The PaaS model provides access to the hardware and system software of the largest providers, also gives an opportunity to use additional tools of deployment and hosting. It allows having the ability to design, deliver, and maintain custom applications, and other resources.

As a software platform PaaS can provide the following services [8]:

– OS – network operating system, for example, Unix-system, including Ubuntu Server, BSD/OS Family, Solaris/SunOS, and others, or different versions of Windows Server).

– Database – a database management system, for example, MySQL, Microsoft SQL, SQL Database, PostgreSQL, Oracle, etc.

– Middleware – software middle layer or connecting (intermediate) software, which is designed to ensure interoperability between different applications, systems and components.

– Software development tools and testing – software tools for web application development and testing (software development environment: software frameworks, libraries, etc. for creating web applications using programming language like Python, Java, PHP, Ruby, JS for Node.js etc.).

– App server – application server for developing, testing, and debugging of web applications.

– Resource allocation in PaaS can be performed at several levels:

– hardware – joint use of server among multiple virtual machines;

– virtual machines – when the virtual machine can be used simultaneously by multiple applications;

– applied – each application can perform multiple tasks in parallel.

For integration EMS distributed simulation system into the cloud the OpenStack [9] is used – freely available platform, that implements a set of opportunities for the creation, control and deployment of cloud services. Synergy architecture EMS and PaaS includes components of EMS, HLA and the OpenStack platform, and also their interaction with each other (Fig. 3).
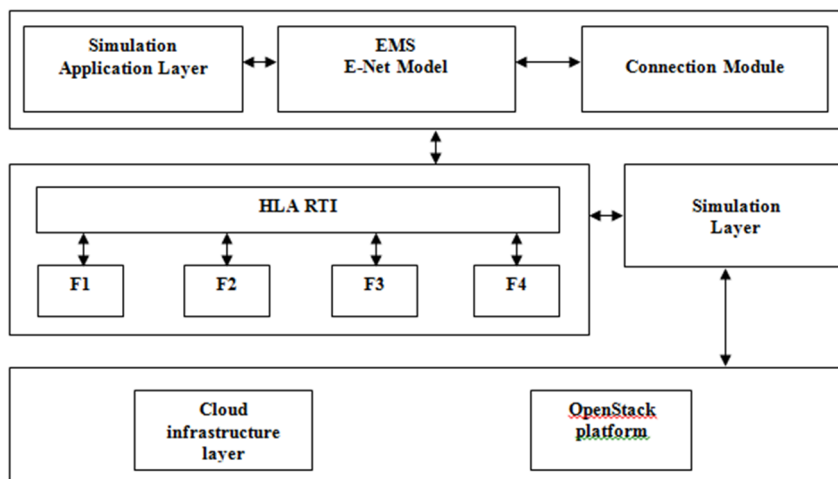
Fig. 3. Architecture EMS and PaaS

Infrastructure as a Service (IaaS). The key features of IaaS [10] in solving planning task consist:

1. The widespread usage of virtualization technology. The client does not buy access to physical computer, and, moreover, computer equipment. But operating time of processor with specific power, needed RAM and disk space, and access channel to the network with certain bandwidth are purchased. Thus, the customer orders and pays only for the computing equipment that is needed for real-time planning.

2. Integrated control system. There was binding software to the hardware platform before, but now is possible to use an integrated control system that enables collaboration OpenStack, HLA RTI and EMS.

3. Availability of elaborated architecture. Companies do not need to design and create IT infrastructure of planning by themselves, and ready-made solutions can be used, up to the environment models. The effectiveness of such an infrastructure is much higher than that are used by individual, not specializing in IT companies.

But the most important thing is that the usage of the IaaS model eliminates all cares of support of IT infrastructure from the company-client. This task goes to the company providing the service.

EMS adaptation under planning with Cloud technologies. EMS system architecture with its use in the cloud is shown in Fig. 4.
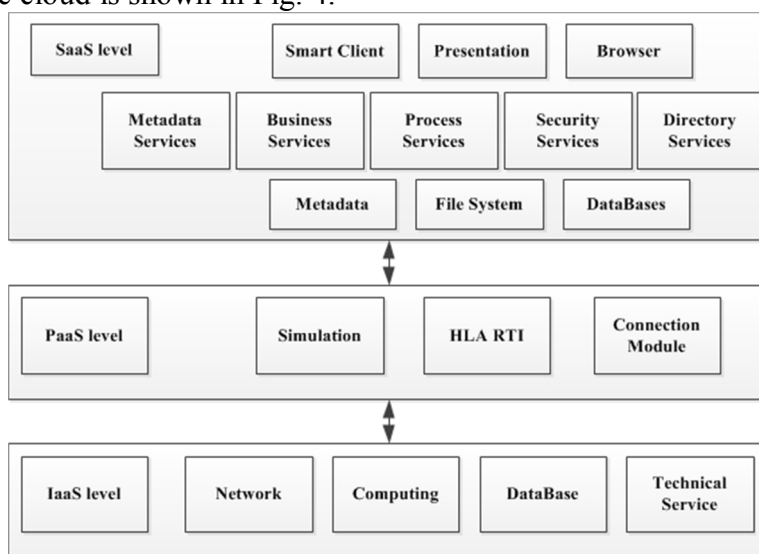

Fig. 4. EMS system architecture in cloud

Process Service provides client interface. Other services implement Business Services that interact with the relevant Data storage for using the business-data. Security Service is responsible for access control to the end user and for the services on the server. Metadata is responsible for configuration management of application for individual users.

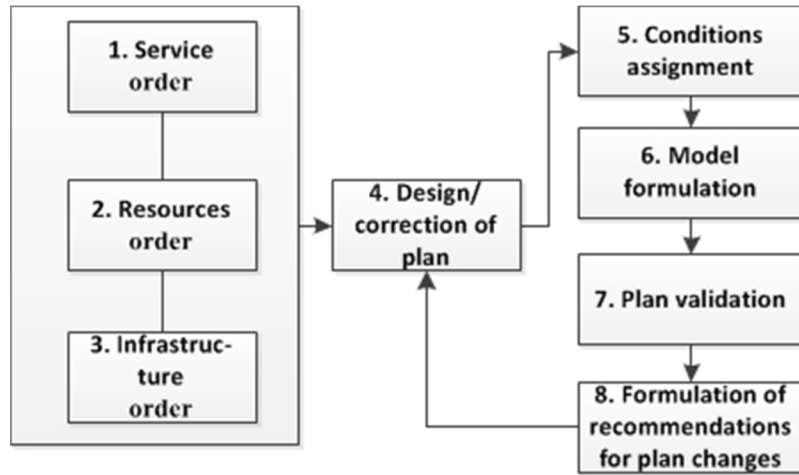The network planning process in the cloud is a sequence of steps shown in Fig. 5.

Fig. 5. Network planning process in the cloud

In the EMS work plan is represented as federate, described by the control E-net (Fig. 6) [3]. This federate is part of the federation - the aggregate of models of planning system (Fig. 7.). Synthetic environment is also presented as one or more federates that simulate the external conditions that influence to the executive plan.
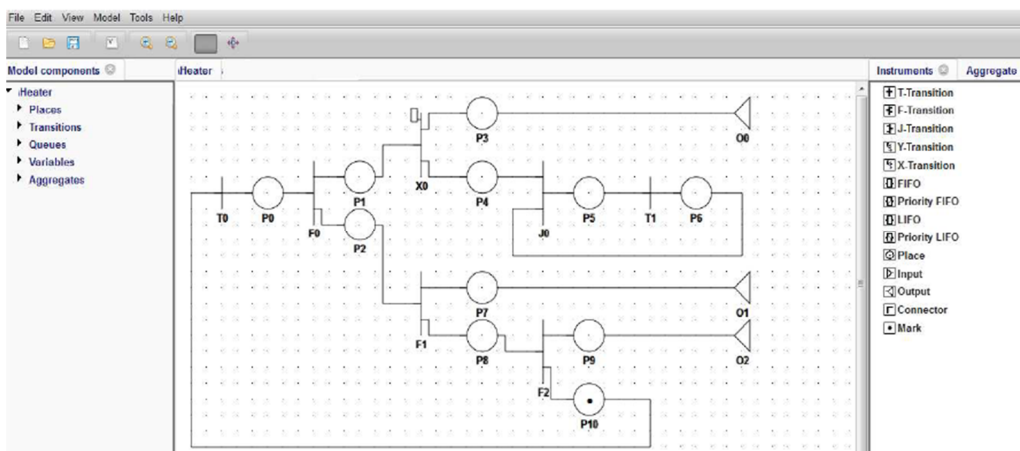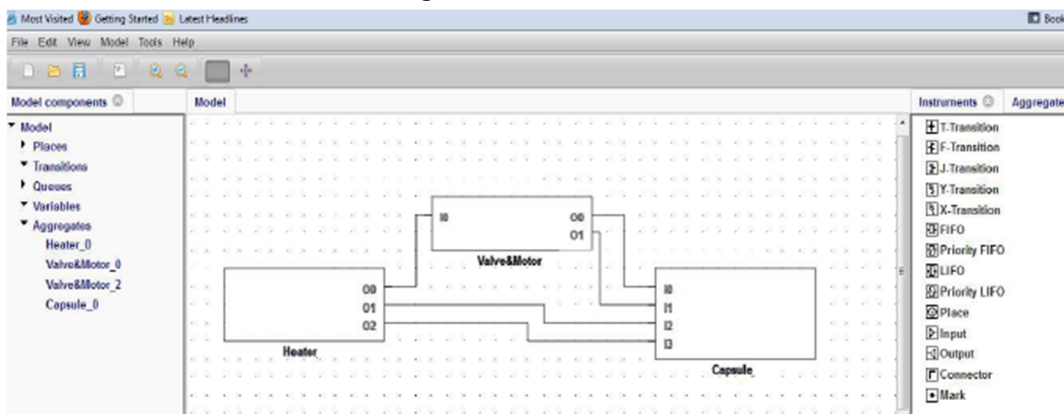

Fig. 6. Plan model in EMS

Fig. 7. Model of network planning system

Conclusion. The approach to network planning based on cloud technologies, presented in this article can be used to design work plans of various levels of complexity. The built-in simulation models are the basis of these plans, including synthetic environment models. This allows the forecasting and assessment of the implementation of generated work plans under conditions of uncertainty. The simulation and planning tools within the three components of cloud technologies will allow monitoring the implementation of the operational work plans, and their timely optimization in real time.

References

1. *IEEE Std 1516-2000*, 1516.1-2000, 1516.2-2000, IEEE Standard for Modeling and Simulation (M&S) High Level Architecture (HLA)(2000).

2. *Казимир В. В.* Верификация реактивных систем с помощью формул темпоральной логики на Е-сетевых моделях / В. В. Казимир // Математичні машини і системи. – 2002. – № 1. – С. 29–40.

3. *Казимир В. В.* Розподілене моделювання в EMS на основі архітектури HLA / В В. Казимир, Г. А. Сіра // Математичні машини і системи. – 2011. – № 4. – С. 125–135.

4. *Buyya R.* Cloud computing: The next revolution in information technology, In Proc. of the lst International Conference on Parallel Distributed and Grid Computing, IEEE Computer Society, Los Alamitos, 2-3 (2010).

5. *Frey Kely L.* Application Service Provider and Software as a Service Agreements Line by Line: A Detailed Look at ASP and Saas Agreements and How to Change Them to Meet Your Needs / L. Frey Sr., Thomas J. Hall. – Aspatore Books, 2007. – 108 p.

6. *Hassan, Qusay F.* Demystifying Cloud Computing / Qusay F. Hassan // The Journal of Defense Software Engineering (CrossTalk). – 2011. – Jan/Feb. – P. 16–21.

7. *Paul, Gil* What Is 'SaaS' (Software as a Service)? [Online]. – Available : http://netforbeginners.about.com/od/s/f/what_is_SaaS_software_as_a_service.htm.

8. *Brandon* Butler PaaS Primer: What is platform as a service and why does it matter? [Online]. – Available : http://www.networkworld.com/article/2163430/cloud-computing/paas-primer--what-is-platform-as-a-service-and-why-does-it-matter-.html.

9. *Open* source software for creating private and public clouds [Online]. – Available : https://www.openstack.org/.

10. *IAAS:* ключевые особенности [Online]. – Available : http://www.inoventica.ru-/informacionnyj_centr/tehnologii/iaas_paas/IaaS_kljuchevye_osobennosti.

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