International Journal of Advanced Engineering and Management Research
Vol. 3 Issue 1; 2018

http://ijaemr.com/ ISSN: 2456-3676

PERSPECTIVES FOR THE DEVELOPMENT OF CLOUD COMPUTING

Olga Leshchenko[1], Oksana Kovtun[2]

[1]Faculty of Information Technology
Taras Shevchenko National University of Kyiv
Kiev, Ukraine,

[2]Faculty of Information Technology
Taras Shevchenko National University of Kyiv
Kiev, Ukraine,

Abstract

Presented architecture, as well as the application of cloud computing technology. A mathematical review is proposed for describing the complex processes of information transformation.

Key Words: cloud computing; cloud computing technology; fog technologies; internet of things; dynamic system

1. Introduction

Cloud computing is one of the most popular areas of IT development. This is the provision of computing services - servers, storage, databases, networks, software, and analytics and much more via the Internet ("cloud"). They are based on scaled and virtualized resources (data and programs) that are accessible to users through the Internet and implemented because of powerful data centers (data centers).

A significant role in the emergence of cloud technologies was played by the creation of multi-core processors and increasing the capacity of information storage devices and the development of such networks as SDN, FTTH [1, 2].

Thus, one can understand that the basis for the creation and rapid development of cloud technologies was the large Internet services such as Google, Amazon, as well as technological progress, which, in fact, suggests that the advent of cloud computing was just a matter of time [3; 4].

2. Introduction Architectureof cloud computing

Scientists of the National Institute of Standards and Technology (NIST) [5] developed a standard cloud computing architecture consisting of: three service models (SaaS, PaaS, IaaS), four deployment models (private cloud - private cloud - public cloud / hybrid cloud - hybrid cloud) and five main characteristics (on-demand self-service/ broad network access / resource pooling / rapid elasticity/ measured service).

SaaS - Software as a Service, subscribers are provided with ready-made application software, fully serviced by the service provider.

PaaS - Platform as a Service, subscribers are granted access to the use of information technology platforms: operating systems, database management systems, development and testing tools and other similar software hosted by the provider.

IaaS - Infrastructure as a Service, the subscriber is given the opportunity to use the cloud infrastructure for independent management of processing, storage, networks and other fundamental computing resources.

The cloud system can function in one of four models:

Private cloud: the cloud infrastructure functions entirely for servicing one organization. The infrastructure can be managed by the organization itself or by a third party and can exist on both the consumer side (on premise) and the external provider (off premise).

Community cloud: cloud infrastructure is shared by several organizations and supports a limited community that shares common principles. Such a cloud infrastructure can be managed by the organizations themselves or a third party and can exist on both the consumer side (on premise) and the external provider (off premise).

Public cloud: the cloud infrastructure is created as publicly available or accessible to a large group of consumers. Such an infrastructure is in the possession of an organization selling the appropriate cloud services/ providing cloud services.

Hybrid cloud: a cloud infrastructure is a combination of two or more clouds (private, public or public) that remain unique entities but combined together in standardized or proprietary technologies that provide portability of data and applications between such clouds (for example, technologies such as packet data transfer for balance of loading between clouds).

When building a model of the cloud computing system, it is necessary to take into account a number of features of the system:

- Clients of cloud systems serve themselves, that is, they have the opportunity to independently access information services;

- Universality of the client's access to the cloud system using information and telecommunication networks;

- The client's ability to access information services using thin or thick clients via the information and telecommunication channel;

- High consolidation of computing resources - combining computing resources in one or several points for customer service with the ability dynamic distributing physical and virtual resources in accordance with customer requests.

In the general case, the composition of the cloud computing environment includes:

1) Hardware platform. The OS environment can be deployed both on existing computing resources, which provides a smooth transition to the cloud infrastructure, and on the hardware platform of the newly created data center (DPC);

2) Virtualization tools. As a virtualization technology, the following types of hypervisors can be supported: VMWare ESX; KVM (kernel virtual machine);

3) Management and monitoring tools. Monitoring tools are designed to monitor the status and signaling of abnormal events in the hardware and software cloud complex. Management tools are software services that provide management of virtual machines using the concept of cloud computing. The most promising platform is OpenStack - an excellent development with the

participation of domestic and foreign professionals. This system will provide: management of the life cycle of virtual machines; a repository with software services; a single interface to access the distributed data store; software, command and graphical interfaces for access to management of virtual machines;

4) Data storage system. It is designed to host and securely store user data. This software component is a service of the cloud computing environment built on the OpenStack Swift platform. The storage service provides reliable storage of data, copies of which are on different servers of the system. In addition, the service provides a program interface REST for data access;

5) Protection service. It is designed to provide the functions of delineation of access to information services, functioning in a virtual environment, and is a set of elements: a firewall subsystem (based on the ITU of the SSPT series); access control service; subsystems of cryptographic protection of data transmission channels.

The disadvantage of cloud computing is that the user is completely dependent on the "cloud" he uses (in which the data and programs he uses are available) and cannot manage not only the operation of cloud computers, but even the backup of his data. In this regard, a number of important issues arise about the security of cloud computing, the preservation of user data privacy, etc.; not all of them have been solved now.

A major problem with the organization of cloud computing in terms of data center equipment is energy savings and the problem of load distribution, since cloud computing in each data center has (or will have in the near future) millions of remote users. Currently, a number of large, including - government and commercial organizations in the USA are closing their data centers (DC), due to too much energy. In fact, the data center can occupy one or more huge buildings.

For clients work in the cloud using the Web-browser (with active use of Asynchronous JavaScript and XML, allowing to reduce the number of referrals from one Web page to another, and thus technology, while user access to the information it needs) and offline-clients whose work based on HTML 5 (special version of HTML for cloud computing).

The implementation of the cloud uses the principles of program and data virtualization and the OMF standard. To interact with the services, the data is transmitted in XML format.

Application interoperability uses standards:

- HTTP (the main Web protocol);
- XMPP (Jabber) - standard for sending and receiving instant messages in XML format;
- SSL (Secure Socket Layer) - the level of secure socket network connections used, for example, in the https protocol.

Major platforms of cloud computing

The Amazon Elastic Compute Cloud, or EC2, appears to be the earliest, most common and best known of the cloud-based platform platforms.

IBM Smart Cloud is a cloud-based, enterprise-level platform. Its cloud services can be provided both as elements of a public cloud, and as components of a private cloud.

Microsoft Windows Azure also supports both public and private cloud services. It is based on the .NET architecture and is discussed in detail in this course. It is very important that there appeared software tools for communication of the Java platform with the Azure platform, which allow working with Azure cloud services using the Java API. All this is discussed below in this course.

Oracle Cloud - similar to IBM cloud, is available in both public and private formats.

Google's AppEngine is a set of cloud services focused on web developers and applications for web hosting. A typical example is the Google add-on for browsers, which provides search using the Google search engine.

There are a number of other less well-known cloud platforms, for example, Kaavo cloud.

3. Application of cloud computing technologies

Cloud services solve a certain set of tasks. As the requirements are different, the hybrid model becomes more popular. As studies show, over the past year, the interest of customers in the hybrid cloud model has grown significantly. Hybrid cloud based on EMC VPLEX and Cisco OTV allows you to almost instant switching from your corporate infrastructure to the provider's infrastructure.

In a hybrid model, one part of the IT infrastructure is located on the customer site, and the other is brought to the provider. Now the cloud platforms of different vendors are isolated, have different characteristics provide different levels of SLA at different prices. It is necessary to make the necessary connection between the various sites, so that you can implement a hybrid cloud infrastructure. An infrastructure of virtual network services is created, allowing customers to change the provider.

When deploying a hybrid cloud and building a complex cloud infrastructure, it is also necessary to ensure efficient management and network interaction between sites. With the last task, virtual routers already offered by Cisco help to cope, which allow you to configure routing between clouds with the help of familiar tools, interfaces and protocols.

The information system (IS) infrastructure provides for the use of the service approach and the possibility of flexible allocation and release of resources as needed. In addition, it is necessary to ensure high efficiency of resource use, to respond flexibly to changes, problems and failures, to ensure reliability and security. The incentive for moving to a dynamic infrastructure is also the increased requirements for fault tolerance of IS services [6].

Instead of the server of the senior class with the decision of the same tasks, the normal two-processor server now consults. The new processors are maximally focused on virtualization technology, which allows more efficient use of physical resources in a virtual environment. All this gave a synergistic effect and allowed virtualization to implement routers, firewalls and cryptic gateways without buying the appropriate physical hardware, which added flexibility to the infrastructure.

Together with the infrastructure of computer systems, the network component changes. Previously, the bandwidth of the data link between data centers was usually limited to 100 Mbit/s and the recovery procedure took up to 24 hours. Applications critical to business required local protection within the main site (for example, a cluster solution) and additional backup on the remote site. With the advent of 10GbE and FC technology at 16 Gb/s, the system recovery time in such architecture was reduced to 1-2 hours, and most importantly - the cost of owning the IT infrastructure decreased.

Experts try at different levels to optimize the availability and resiliency of the data center, reduce energy consumption, reduce risks and control costs. New developments and approaches in the field of architecture of data centers, IT infrastructure, and network technologies are becoming important areas of struggle to reduce costs.

Convergence at the level of physical, software and user interfaces consists in combining dissimilar programs that were created by different programmers at different times. Ultimately, when you combine, everything becomes more complicated, and you get bulky products that create many problems.

Convergence at the functional-applied and organizational levels implies the merging of the same functions into macro functions, together with the redistribution of data and resource flows, as well as mechanisms for execution. Usually, such actions entail a complete reorganization of business processes, structures and a variety of information schemes.

In order to achieve the desired result of system integration, it is necessary to select and use common points, as it can be imagined that the systems to be converged will have a uniform structure, otherwise if they are far apart, then there are many difficulties that are relevant not only to internal structure of the systems themselves, but also external "interfaces" of interaction.

New technologies are developing - fog computing. It is a model in which data, processing, and applications are concentrated in devices on the edge of the network, rather than being almost entirely in the cloud. This concentration on the periphery means that the data can be processed directly on the user's smart devices, rather than being directed to the cloud for processing.

Fog computing is one of the approaches to realizing the demands of the ever growing number of Internet devices connected to the Internet, which are often called Internet of Things or IoT. In a foggy computing environment, most of the processing will occur at the edge of the network, rather than transferring the entire amount of data to the cloud. At the same time, foggy calculations are not at all a replacement for the cloud model as such. On the contrary, she continues the ideas and actively develops the very concept of cloud computing, following the aspects of Internet of Things. Thus, foggy computing can be perceived as a convergence of technologies of the Internet of things and cloud computing, is becoming more widespread, rapidly developing and promising for further research.

For modern heterogeneous systems, the main issue is the search for the optimal degree of integration. You can have a fully integrated system, but at the same time, there is a complexity of its support and a sharp increase in the financial component. Unlike homogeneous, heterogeneous information, systems can be different in a variety of criteria: from its structure and ending with the protocols used, although any system has its own scheme for processing, storing and operating data, but the priority component that determines it is the architecture of the system. Therefore, when the various systems merge, the above parameter comes first.

4. Research cloud computing technology

There are complex tasks when using and building a complex cloud infrastructure, in which it is necessary to ensure effective management.

Thus, complex tasks arise when using and building a complex cloud infrastructure, in which it is necessary to ensure efficient management. In addition, the convergence of Internet technologies of things and cloud computing is becoming more widespread and is rapidly developing and promising for further research.

All these aspects require the study of cloud computing technology, in which complex information conversion processes occur.

A dynamical system is any object or process for which the concept of state is unambiguously defined as the aggregate of certain quantities at some time, and a law is specified that describes the evolution of the initial state with the passage of time[7].

The mathematical description of such a system has three main components: phase space, time and the law of evolution [7]. The phase space is a certain set, the elements of which are identified with the state of the system. Consideration of the evolution of the system requires time. Depending on the problem, either non-disruptive time (when the state of the system is interested in each moment) or discrete (when the state of the system is interested in separately isolated instants of time) can be considered. It is believed that time can unlimitedly extend forward, and in some systems, and back: the past is defined for reversible processes and is not defined for irreversible processes. Continuous time is naturally identified with the numerical axis for reversible processes and with the semiaxis [0; + ∞) - for irreversible processes, respectively, discrete time is identified with the set of all or only integer nonnegative integers (respectively, for reversible and irreversible).

The law of evolution of a system is a rule that allows us to determine the state of the system at time t, if all states are known at all the preceding moments of time.

Let's consider that if at the moment the system is in the state $x \in X$ (X is the phase space), then in a time interval t the system will be in a uniquely determined state which we denote by $F(x,t)$. For a fixed t, we obtain a map $\varphi^t : x \to F(x,t)$ of the phase space into itself. Such transformations corresponding to different t are related to each other. So if the system is in the state x, then in a time t it will be in the new state $\varphi^t(x)$, and even in time s – inthe state $\varphi^s(\varphi^t(x))$. However, in the time $s + t$ the system from the state x goes to the state $\varphi^{s+t}(x)$. Thus, for all $x \in X$ we have

$$\varphi^{s+t}(x) = \varphi^s(\varphi^t(x))$$

that is

$$\varphi^{s+t} = \varphi^s \circ \varphi^t \quad (1)$$

Equality (1) is valid for all admissible s and t; and it says that the family $[\varphi^t]$forms a semigroup. Besides

$$\varphi^0 = id_x \qquad (2)$$

(where $\varphi^0 = id_x$ is the identity map on X) for how many times the system state does not change for zero time.

Let T denote one of the sets □,□,□$_+$,□$_+$. Then a dynamical system is a family $\{\varphi^t\}_{t \in T}$ of mappings $\varphi^t : X \to X$ of some non-empty set X to itself such that (1) and (2) hold for all admissible s and t.

If $T =$ □ , then the system is called a flow if $T =$ □$_+$- is a semitroup; in both cases speak of a system with non-brewing time.

A set X is called the phase space of the system, and the map φ^t is an evolution operator.Usually the phase space of a dynamical system is endowed with some structure: for example, a measure, a topology, a structure of a smooth manifold; evolutionary operators are consistent with this structure, that is, accordingly, preserve the measure, and are continuous, smooth. Correspondingly, the directions of the theory of dynamical systems are distinguished: ergodic theory, topological dynamics, differential dynamics (the theory of smooth dynamical systems), etc.

The discrete dynamical system is completely determined by one mapping $\varphi = \varphi^1$.

Continuous dynamical systems are most often prescribed not by explicit indication of evolution operators, but by autonomous differential equations.

Suppose that in the open domain U of the space $\mathbb{R}^n$ there is an autonomous system (with independent right t-sides) of the system of differential equations

$$\dot{x}^i = f^i(x_1, \dots x_n), \quad i = 1, \dots n \quad (3)$$

Which has a unique solution with any initial condition belonging to U (for this there is sufficiently continuous differentiability of the functions f^i in the domain U). Suppose that each solution of the system can be extended to the entire real axis. Then the system (3) defines a continuous dynamical system with phase space U and evolution operators $\varphi^t : U \to U$ that put the points $x_0 \in U$ in the moment t of the solution ψ of the system (3) with the initial conditions $\psi(0) = x_0$.

Differential equations are naturally considered on differentiable manifolds,and autonomous differential equations are in a natural connection with vector fields.

The most important properties of dynamic systems: integrity, the interaction of the dynamic system with the external environment, the structure of the dynamic system, the infinity of cognition of the dynamic system, the hierarchy of the dynamic system.

Therefore, it is proposed to explore the development of cloud infrastructure as a complex dynamic system. In this case, differential equations are provided that provide the necessary effective control.

5. Acknowledgment

Thus, cloud computing technologies can be used in heterogeneous information systems, in which it is necessary to provide efficient management. The development of cloud infrastructure can be explored as a complex dynamic system. This will significantly save the resources needed to ensure the functioning of information systems. The implementation of information systems using cloud computing technologies will ensure the management of information processing processes and the necessary level of access control to the physical resources of information systems, which ultimately leads to a reduction in the total cost of creating, developing and functioning information systems.

References

[1] Kravchenko Y. Topology of Optical Networks FTTH (Fiber-to-the-Home) / Y. Kravchenko, S. Tolyupa, O. Barabash, A. Trush, O. Leshchenko // Bulletin of the National Technical University "KhPI". Series: New solutions in modern technology. – Kharkiv: NTU "KhPI", 2017, 7 (1229), pp. 150 – 155.

[2] Barabash O.Optimization of Parameters at SDN TechnologieNetworks/O. Barabash, Y. Kravchenko, V. Mukhin, Y. Kornaga, O. Leshchenko // International Journal of Intelligent Systems and Appli № 9. – Hong Kong: MECS Publisher, 2017 cations, - P 1-9.

[3] Gubarev V., Savulchik S. Introduction to cloud computing and technology. - Novosib: NSTU, 2013. - 48 p.
[4] Devyatkov V. Methodology and technology of simulation studies of complex systems: current state and development prospects: monograph. - Moscow: University. Textbook: INFRA-M, 2013. - 448 p.
[5] Mell, Peter and Grance, Timothy. The NIST Definition of Cloud Computing. Recommendations of the National Institute of Standards and Technology. NIST (20 October 2011).
[6] Leshchenko O. Features of simulation of the control system of the infocommunication network/ O. Leshchenko // Telecommunication and information technologies. - №2. - 2014. - p.93-98.
[7] Каток А. Б., Хасселблат Б. Введение в современную теорию динамических систем / М. : Факториал, 1999. — 768 с.

Author Profile

Oksana Kovtun. Candidate of Physics and Mathematics since 2006. Doctor's degree was awarded in 2012. Scientific interests: projection-iterative methods for the solution of the research of overdetermined tasks, information technologies

Olga Leshchenko Received a candidate's degree in technical sciences in specialty 05.12.02 and a diploma of associate professor in 2013 and 2014, respectively. Works on topics of info communication networks, Internet things, cloud computing, control systems. She is currently working at Kyiv Shevchenko University.