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THE MODEL FOR ASSESSMENT THE RELIABILITY OF STRUCTURES IN VIRTUALIZED DATA CENTERS

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Abstract: In this paper has been proposed model of communication system with dynamic network topology in which the process of changing the topology graph over time is to create or break connections between components within a single physical server or between pairs of components that are located on different machines. An essential criterion is the availability of system performance connectivity graph at the time of transition from one state to another topological and fixed number of nodes. Analysis showed that virtual topological structure of such a cloud network will depend on the probability of failure in the middle of the road segment. The probability of blocking close to zero when the number of available channels is 20-30% of the total subscribers
Keywords: assessment the reliability of structure, virtual structure, virtualized data center, structure stability, cloud technology.

Introduction

The modern society was faced with challenges arising from insufficient knowledge of the properties of large networks consisting of hundreds of thousands of nodes and links. Especially difficult to study is large stochastic network such as Internet, social and transport networks, cloud networks that are formed very quickly and relatively rapid changing the interaction of many random and deterministic factors.

In all dynamic networks, there is one problem - the size of which is constantly changing as a result of failure or the addition of a path, and changing topologies. Just that is makes it difficult to search and access to information.

One of the limitation factors of existing dynamic networks has difficulty transferring high-speed real-time traffic, caused by peculiarities of network protocols and channel levels used. At the data link layer protocols are used, based on a random set of access [1-3]. The disadvantage of using dynamic networks is collisions.

An alternative is to use a deterministic multiple access - when the right to use the transmission medium is shared between network devices in advance. Using this access avoids collisions on the network, and consequently transmit information at high speed and low latency

Considering all aspects in this paper we has been proposed model communication system with dynamic network topology, specifically cloud network, in which the deterministic multiple access transmission medium of information and assessment of reliability (probability of failure a certain way) the proposed model by means of simulation.

Statement of problem

Nowadays the market of services in cloud computing is sufficiently developed. The most famous are the decision by Microsoft (Microsoft Azure), Google (Google Apps Engine), Amazon (Elastic CloudComputing, Simple Storage Service), IBM (Blue Cloud), Nimbus, Oracle and others. Except large corporation the service of cloud computing also provide less powerful company. On the market there are free solutions (iCloud, Cloudo, FreeZoho, SalesForce, etc.). Despite the variety of services provided as a service in the cloud-based all systems are quite typical hardware and software that provide the system and provide the appropriate level of flexibility and elasticity. Generally, under cloud-understand system a number of physical servers by using virtualization technology run performance of a service component at its free virtual resources (individual virtual machines) Accordingly, hardware and software for cloud-systems, with some probability may decline. To minimize the probability of failure of the system and reducing the time of recovery, cloud-systems use the same principles as in the majority of the distributed processing of data (backup, reallocation of computing resources, etc.). These approaches allow the user to partially hide the real state of things and create the illusion of failure of the system. However, statistics bounce cloud-systems indicates that the known approaches are not always sufficiently effective (Table 1) [4].

Table 1

Statistics failures cloud-systems

№	Service provider	Service	Date	Time of stand idle
1	Google	Gmail, Google Apps Engine	24.02.2009	2,5 години
2	Google	GoogleSearch	31.01.2009	40 хвилин
3	Google	GoogleGmail	9.03.2009	22 години
4	Google	Google Network	14.05.2009	2 години
5	Amazon	Amazon Elastic Cloud Computing	11.06.2009	7 годин
6	Amazon	Amazon Elastic Cloud Computing	9.12.2009	5 годин
7	Amazon	Amazon Simple Storage Service	15.02.2008	2 години
8	Amazon	Amazon Elastic Cloud Computing	21.04.2011	27 годин
9	Microsoft	Microsoft Azure	13-14.03.2008	22 години
10	Microsoft	Microsoft Hotmail	12.03.2009	5 годин
11	Microsoft	Microsoft Sidekick	4.10.2009	6днів
12	Flexiant	FlexiScale	31.10.2008	18 годин

Analyzing the statistics presented in Table 1, it should be noted that not all cases were the result of failures only simple. While denial of service Microsoft Sidekick were completely lost personal data [4], who later managed to recover, but only partially. Thus, despite the rather high level of implementation of known solutions to improve the reliability of cloud-systems, issue analysis bottlenecks, to find approaches to address them and improve the reliability and efficiency of operation of the latter, is important and needs further research.

Implementation of mathematical model of structure

The simplest model structure (topology) network is unoriented (oriented) graph *G* with many vertices *V* and set of edges (arcs) *E*, which correspond to nodes and lines. Each system or network can be represented as a graph. Structural model of cloud network - is graph, whose vertices are virtual machines, and edges - physical channels used to transfer each component service. The simplest model of structural reliability (reliability structure) network - random graph $(G; p)$ where $p = \{p(\varepsilon); \varepsilon \in E\}$, characterized by the removal of the independent graph *G* edges (arcs) $\varepsilon \in E$ with probability $q(\varepsilon) = 1 - p(\varepsilon)$.

Random graph (G, p) is called binomial random graph model, because it can be described in terms of $|E|$ Bernully independent experiments, remove edge $\varepsilon \in E$ with probability $q(\varepsilon)$ independent of other edge or equivalent, start with the blanks on set of vertices *V* and select edge $\varepsilon \in E$ independently with probability $p(\varepsilon)$ [5]. In this model we are dealing with the family of all σ subgraph *G* (on the set of vertices *V*) and each $N \in \sigma$ assigned multiplicative probabilistic measure:

$$\mu(H; p) = \prod_{\varepsilon \in E(H)} p(\varepsilon) \prod_{f \in E(G)-E(H)} q(f) \qquad (1)$$

The most common characteristics of reliability - is probability $R(G, s, p, K)$ that from the selected source s in said selected set of vertices $K \in V(G)$ there is a path to all the other vertices of $K - \{s\}$. It is called terminal reliability *k*- where $k = |K|$. Obviously:

$$R(G, s, K; p) = \sum \{\mu(H; p) : H \in \sigma\} \qquad (2)$$

where the summation goes along the subgraph H, K which is one component connectivity subgraph H. However, reliability is a broader concept. In network reliability characterize more as vitality or the system's ability to quickly and seamlessly restore normal operating status. However, this concept can be characterized and how the system's ability to perform its functions for a long time that maximum quality is reliable. The concept of reliability and survivability in the theory of complex systems (which is the cloud network) are interrelated. Reliability is defined as a complex object property, including properties of reliability, survivability, durability. The most important component reliability is the property of vitality that characterizes the system's ability to continuously maintain fitness in the given conditions and at a given interval operation

To assess this parameter in the cloud system must be clearly understood that the topology of the network is dynamic and will change constantly. In our model, we estimate the survival of the structure in terms of setting the probability that the two segments of the service (components) the next time there will be connections that exist at least one edge to be the "key link" to connect these segments . However, the probability of existence of edges (arcs) direction will depend on the probability of failure of a certain way in the middle segment (ie between virtual machines with a single service components exist at least one channel for transmission)

Let the have some part of the cloud network, which will be the initial time *t* the number of inpatient units (virtual machines) and the corresponding number of physical servers and topological structure will appear as shown in Figure 1. For example, suppose that component *b* virtual machine is available through *B*. After a time *Δt* component *b* moved and is now available for service through the machine *C*. It should be noted that segment topology change. Component *b* again but moved to another segment and now available after B_1

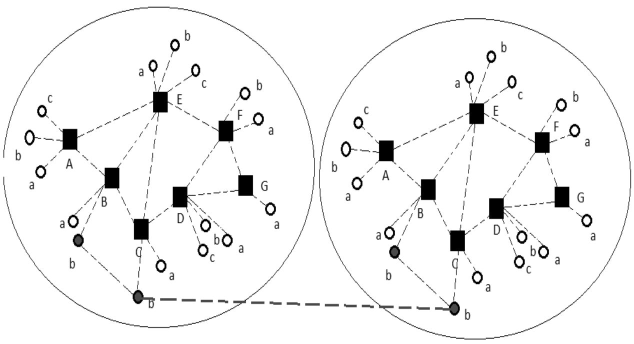

Fig.1. Example cloud network with dynamic topology

Fod determine the probability of blocking in circuit switched systems used Erlang formula. Data obtained through depending formulated A.K. Erlang concept of statistical equilibrium (probable-Multilateral process is in a state of statistical equilibrium if its probabilistic characteristics do not depend on time). The concept of statistical equilibrium contributed to practical application and further development of the theory of probability. For the first Erlang formula lossy system for blocking probability is

$$P_k = \frac{\dfrac{\left(\dfrac{\lambda}{\mu}\right)^k}{k!}}{\sum_{i=0}^{m} \dfrac{\left(\dfrac{\lambda}{\mu}\right)^i}{i!}} \qquad (3)$$

However, for cloud networks has packet switching characteristic. In the method of packet switching entire message is divided into packets of fixed length. Each packet is transmitted independently. This method is very flexible because it does not need to wait for the full message of acceptance in the intermediate nodes, in the case of a distortion of the package is not necessary to repeat the transmission of other packets. One channel of communication can simultaneously transmit packets with different messages of different subscribers, which increases the efficiency of the channel. Among them are the method of switching virtual circuits and the transfer method datagram

The method of switching VCs is that before the connection to the network sent a special package, which passed it, some sets of links yii virtual channel. Thus, virtual channel - is sequence of transmission links leading from the sender to the recipient. Each virtual channel is assigned a unique number. At any time network can not be two virtual channels with the same numbers. After setting up virtual channel message received packets specified channel. With the address information such packages contain only a virtual channel. After the virtual transmission channel splits. The channel was called virtual because, unlike dial-up or appointed, the real channel it uses a specific virtual channel can transmit packets simultaneously multiple virtual channels. This increases the efficiency of the channel. The method of switching virtual circuits can reduce the official address information by 8-10% compared with the method datagram. In addition, operations analysis package to each node (and the corresponding delay) is simplified - only analyzed the channel number.

If the message transmission datagram divided into separate independent packages - datagrams. Each datagram must include the address of the sender and recipient. Datagram was numbered and transfer independently from each other. The recipient of the message creates datagram. Datagram require more analysis in the intermediate nodes transmit than packages of virtual channels. On the other hand, datagram a message is not tied to a certain route network. They can transmit different routes at the same time, reducing the length of the entire message transmission.

Therefore, for assess the probability of blocking cloud segment used Erlang formulas which may approximately describe the probability of packet blocking systems, but rather determined by complex methods.

The simulation results

Define the probability of failure of each VM is 10^{-3}. To calculate the probability that the two components of a physical machine the next time there will be a connection must be considered:

1. The location of the node b and the access point B in the middle segment;

2. Features points virtualization, such as;

3. The number of units in each segment (this model was seen that the number of units equal to 1000, and the number of available channels - 400);

4. Intensity receipt of requests for service from one user in the middle segment and its length (4 clips / h, 4000 pp.);

5. Current status of each node and VM (active (1) or passive (0))

After the formation of necessary conditions, using analytical and statistical methods for evaluating the probability connection and its reliability estimate we need an option. Modeling the traffic in such a system failure and study each node in the middle segment, and the probability of blocking in the middle segment carried out using the software package Matlab. Results will be presented in table 2:

Table 2

Simulation results

The number of available channels	Probability of blocking	VM which dedication	Probability of failure within the path segment (for model on the fig.1)
The moment of time before moving			
100	0.995000	B	0.99965
130	0.993500	C	0.62530
160	0.992000	D	0.87426
190	0.980750	E	0.65291
220	0.583100	F	0.88102
250	0.020750	G	0.99965
The moment of time after moving			
280	0.001305	C	0.99934
310	0.000021	D	0.87416
340	0.000006	E	0.64282
370	0.000001	F	0.86953
400	0.000000	G	0.99912

After analysis of the results we can say that:

1. Probabilities locks in the middle segment depends on the number of available channels and network congestion and affect the connectivity of each node point cloud rendering services;

2. Probability of failure in the middle of the road segment will be greater if the time to move and a time after moving node will carry out the transfer through the same point cloud rendering of services (particularly in cases where at least one of the nodes on the route will change its status)

3. The probability of a connection, the caller when moving from one segment to another depends on the reliability of the road in the middle of each segment.

So, vitality topological structure of such cloud network will depend on the probability of failure in the middle of the road segment, which will be greater if the time to move and a time after moving node will carry out the transfer through the same point cloud rendering of services (particularly in cases when at least one of the nodes on the route will change its state) and the probability of blocking in the middle segment, which depends on the number of available channels and network congestion and affect the connectivity of each node point providing cloud services.

The dependence shows that the greater the number of channels available to query the VM, the less likely a lock segment. In general we can say that the probability of blocking close to zero when the number of available channels is about 20-30% of the total. At low values in the mid-block segment will increase the likelihood that the two segments in the next time there will be connections

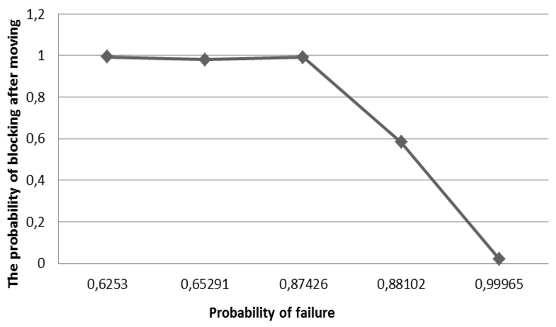

Fig.2. The dependence probability of blocking before moving from probability of failure

During the simulation investigated the state of the network, when the number of nodes in each segment is 1000, and the number of available channels - 400. As to the number of available channels and their impact on the probability of blocking in the middle of each segment, there could be argued that the more channels the less likely locks. It can be seen from Figure 3

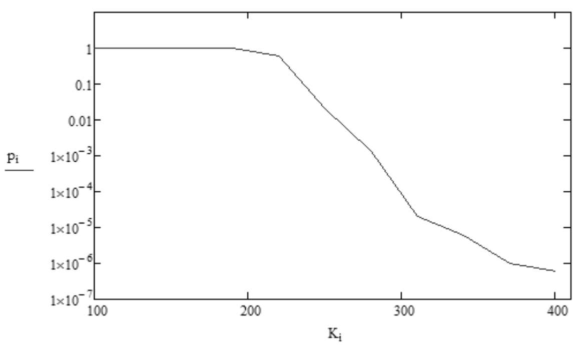

Fig. 3. The dependence probability of blocking from the number of channels

Conclusion

In this paper has been proposed model of evaluation survivability topological structure and general cloud networks based on probabilistic method. It is estimated survival of structures in terms of setting the probability that the two segments in the next time there will be connections that exist at least one edge to be the "key link" to connect these segments. However, the probability of existence of edges (arcs) direction will depend on the probability of failure of a certain way in the middle segment (ie between subscribers in the middle of each segment there will at least one route) and each VM, as well as the likelihood of locks in the middle of each segment. After analysis of the results we can say: topological structure of such a cloud network will depend on the probability of failure in the middle of the road segment, which will be greater if the time to move and a time after moving node will carry out the transfer through the same point cloud provide services (particularly in cases where at least one of the nodes on the route will change its state) and the probability of blocking in the middle segment, which depends on the number of available channels and network congestion and affect the connectivity of each node point cloud rendering service.

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