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VIRTUAL TABLE-SIMULATOR FOR MONITORING DISTRIBUTED OBJECTS

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Abstract

There is presented a determination to the concept of "a distributed subobject for monitoring". There are revealed the common features of such objects. There are analyzed the virtual and hardware cloud computing technologies. There is described the technical structure of the "table simulator" based on the "Cloud technology" of the KSTU automation of production processes department. The basic provisions of the "table simulator" software structure are proposed. There are formalized the basic provisions for constructing a generalized model of the distributed object for monitoring. There is defined the problem of studying the generalized model of monitoring (Conclusion).

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1. Introduction

Distributed objects requiring their own condition monitoring can be subobjects of various industries, railway transport, transporting electric energy, water, gas, oil and oil products, public utilities structure and other material and physically tangible structures located in huge territories. Here the concrete examples can be gas- and oil pipelines, pipeline networks of the systems of heat and water supply, overhead power transmission lines (OPTL). Let us call material (and later on virtual) flows the “products” of the corresponding analyzed subobjects.

At the same time there existed, exist now and are developing promptly the telecommunication objects (TO) of the virtual and hardware structure using wire and wireless channels of information transfer both in analog, and digital representation. TO belongs to the class of the distributed subobjects requiring monitoring of their own status, too.

An original distributed subobject is the training remote systems (TRS) performing the functions of training and retraining experts. In the TRS by the local, global, wire and wireless telecommunication networks there is performed the circulation of arrays of the electronic information displaying the components of the TRS "products", such as "KNOWLEDGE- TESTS", "KNOWLEDGE-ANSWERS", "KNOWLEDGE-MARKS", "KNOWLEDGE- TRAINING ALGORITHMS.

Possessing individual properties and characteristics, various subobjects of monitoring have also the common features uniting them in a uniform class of the distributed analyzed and studied objects. Such basic features are:

- the network structure of material or virtual channels of transferring and transporting flows according to the material or virtual "products" of the distributed monitoring subobjects;
- a delay in the “products” movement";
- the existence of the determined and stochastic hindrances imposed on the virtual information "products" and losses of the material "products" in their movement by the channels of transportation;
- the existence of various options of power costs of the process of transporting both virtual and material "products".

To study physically the distributed objects for the purpose of developing effective monitoring systems is necessary but very expensive in the material, financial, technical and time indicators. Therefore the idea of building the hardware and virtual table simulator of the distributed monitoring subobject based on the local global telecommunication structures can have the right for existence and development. A prospective TO structure in this aspect is the so-called "Cloud technology" [1].

2. Analyzing virtual-and-hardware cloud technologies

At educational institutions cloud services have initially appeared generally as a free hosting of post services for students and teachers. The other numerous instruments of cloud computing for education have not been practically used owing to the insufficiency of information of them and the absence of practical skills of their use for educational purposes.

The use in the educational process of the innovative technology, i.e. "cloud computing" gives an opportunity for educational institutions to use through the Internet computing resources and software applications as services, permits to intensify and improve the training process. Examples of the modern services constructed on the basis of the technology of cloud computing for education are Live@edu from Microsoft and Google Apps Education Edition [1].

Cloud computing is a model of providing a universal network access to the general pool of the configured computing resources (networks, servers, data storage devices, applications and services) at any time. The user actually uses only the client support as an accessor to services, platforms and data, the entire infrastructure of the information system is at a service provider [2].

The National Institute of Standards and Technology (NIST) of the USA defined the following characteristics of cloud computing [3, 4]:

1) self-servicing. The user defines independently the requirements to computing resources (access time, data processing rate, volume of storable data, etc.);
2) free network access. The user is offered a universal access to the resources of the data communication network regardless of the type of its terminal unit (a computer, a notebook, a pad, a smartphone, a TV set, household appliances, etc.);
3) the pool of resources. The provider of the cloud service integrates resources in a uniform pool for dynamic redistribution of capacities in the course of servicing a great number of users with supporting scalability of services in case of the demand change, i.e. the required services shall be provided with the guaranteed quality of service (QoS);
4) elasticity. The services shall be provided quickly and elastically, expanded or narrowed in the automatic mode at any moment, without additional costs for interaction with the provider. Computing resources and the selected space volume can change permanently depending on the user’s requirements;
5) accounting the consumption and monitoring. The provider executes automatic monitoring, the assessment and optimization of the resources consumed by the user (the volume of storable data, the traffic, the throughput, the number of transactions, etc.). By the results of monitoring a report is submitted that provides transparency of using the "cloud" services.

From the provider side, "cloud" technologies permit to use smaller hardware-software computing resources, due to their representation for rent to users only for the time of the service using instead of the constant presenting capacities for subscribers.

From the user side, "cloud" technologies permit to receive services at any time and in any place from computing means of small power, using the paradigm of the "thin" client, owing to the high level of accessibility, scaling and elasticity without the need for purchasing, installing, servicing, administering and upgrading the own hardware-software platform.

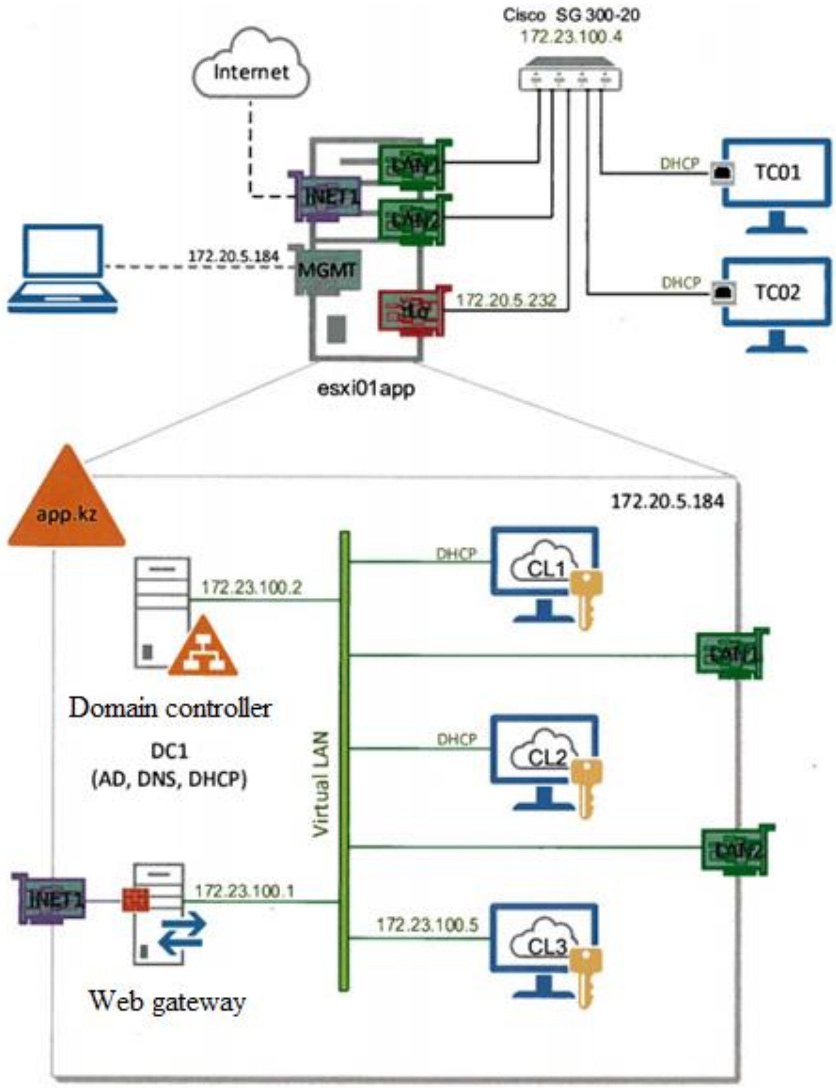

Figure 1. Physical and logical diagrams of the table simulator

3. Technical structure of the "table simulator" based on the "Cloud technology" at the KSTU APP department

In Figure 1 there are presented physical and logical diagrams of the table simulator based on the complex of technical means "Cloudy Technology - Thin Client" of the KSTU APP department.

In the structure of the table simulator there is the following equipment:

1. A server. It performs the function of information collection of all distributed systems. The HP company server supports virtualization needed for installation of cloud computing. The model is ML 350p. Technical characteristics:

a) the processor: IntelXeonE5-2620v2, 2,1 Hz, 6 kernels, the cache memory: 15 Mb, quantity: 2 pieces;

b) the random access memory: 32 GB (8 x 4), PC3L-12800R(DDDR3-1600LV);

c) the controller: HP Smart Array P420i;

d) hard drives: 8 x 300 GB, the total memory: 2,4 Tb, SAS;

e) software: HP iLO Management Ingine, HP Insight Control;

f) the power supply unit: 460 W.

In case of increasing the quantity of the distributed objects it is necessary to increase the server power (perhaps it will be required to install in parallel a server with the same technical characteristics.

2. Thin Clients (TC): computers that imitate the monitoring system elements placed at the points (nodes) of the distributed objects (for example, for the system of heat supply of the megalopolis (HSM) directly at the thermal node). From the TC there will be received control information to the local and global network, and then to the table simulator server.

There have been selected and installed thin clients of the HP company. The model is t510. Technical characteristics:

a) the network interface: 10/100/1000 Gigabit;

b) the processor: VIAEdenX2 U4200, 1 Hz, 2 nuclear;

c) the ports: 6 USB, 2 PS/2, 1 RJ-45, 1DVI-I, DVI-D, 1 VGA.

In the table simulator there are 6 (six) thin clients.

3. The elements of the distributed technological objects, both material and virtual are imitated on the personal computer; these are PC included in the Internet network (both in the local and in the global, cloudy). Eighteen such personal computers have been originally placed in the educational classes.

4. The multiplexor: for connection of the server with thin clients. The Cisco multiplexor has been selected. The model is SG300-20. Technical characteristics:

a) the interface ports: 18 x RJ-45 Gigabit Ethernet;

b) optical interfaces: the ports:

- 2 x RJ-45 Gigabit Ethernet;
- 2 x SFP.

c) multiplexing:

- supporting the standard 802.1d STP;
- fast convergence with the help of 802.1w (Rapid Spanning Tree [RSTP]) is included by default;
- Multiple Spanning Tree instances using 802.1s (MSTP).4.

The multiplexor operation security is ensured by:

- encoding the entire HTTP traffic through SSL;
- IEEE 802.1X;
- RADIUS authentication, MD5 hash; guest VLAN; mode of one/several hosts;
- support time 802.1X;
- dynamic assignment of VLAN;
- isolation of the 3rd level: permission/prohibition of routing between IP subnets or directly the connected IP networks;
- isolation of the 2nd level: Private VLAN Edge (PVE) levels with community VLAN;
- ports security: MAC addresses binding to the ports, restriction of the quantity of remembered MAC addresses;
- protection against storm: Broadcast, multicast and unknown unicast;
- protection against DoS-attacks;
- TCP congestion avoidance.

Access controlling lists (ACL):

- support to 512 rules;
- limiting the passage band in dependence of the initial and finite MAC addresses, VLAN ID or the IP address, the protocol, the port, the priority of differentiated services code point (DSCP)/IP, the initial and finite ports TCP/UDP, the priority 802.1p, the Ethernet type, packets of Internet Control Message Protocol (ICMP), packages of IGMP, the TCP flag.

Prioritization of the traffic:

- sequence;
- strict priority and weighted round-robin (WRR);
- queue is assigned depending on differentiated services code point (DSCP) and class of service (802.1p/CoS);
- restriction of speed: input policies; in VLAN, on ports.

5. Uninterruptible Power Supply Unit (UPSU). There is mounted the UPS of APC. Technical characteristics: power is 3000 VA.

4. Basic provisions on the "table simulator" software structure

We will give some basic provisions on the structure of the system software (SS) of the "table simulator". Obviously, in the process of forming the research problems of monitoring distributed subobjects, a separate component of the software made a specialized program supporting each *PCoIP data transfer protocol.*

PCoIP (PC-over-IP, i.e. a personal computer over the Internet protocol is a proprietary data transfer protocol used in decisions for delivery to terminal units of the remote desktop. It has designed and developed by the Teradici company. There exists both a hardware decision providing data forming and data handling of the remote desktop and the program implementations supporting this protocol [5].

The main idea of cloud computing is that the entire basic software is settled down in the Internet. What is necessary for the User shall be received in the server of the Internet service provider or in the server of the table simulator [1]. In relation to monitoring the distributed subobject, DSM, in this work this principle is transformed as follows [6]:

The server, the multiplexor, the Ethernet-adapters, 6 workplaces ("thin clients"), 18 notebooks (clients' computers placed in the educational classes), table No. 1 with the frequency-controlled drive, a simulator of pumping aggregates, the own PC and the PC with the automated system of scientific research (ASSR), table No. 2 with the own PC, the PC with the information graphic system of planning and decision-making (IGS DPM) of the TGID-05 type integrated with the SCADA-systems, service equipment (uninterruptible power supply units, printers, scanners, graphic screens, etc.) make the hardware of the table simulator of the DS monitoring.

The architecture of this technology will have the three-level structure (Figure 2) consisting of a master server of the cloud at the first level; a cluster of small power servers of the dispatcher service at the second level; 6 thin clients, the server nodes at the third level.

At the first level the master server executes the distribution of input data between the server nodes of the cluster of the local network. At the second level the server nodes distribute data between "thin clients". The results of the parallel processing of these "thin clients" are accepted by the processor of the corresponding server of the second level, aggregated and transferred to the a master server of the cloud where users' requests are handled and the data of remote nodes are collected.

A thin client in computer technologies is a diskless computer client in the networks with the client server or terminal architecture that transfers every task or the most part of tasks for information processing to the server.

When operating in the terminal system all the applied programs, data and parameters of settings are stored in the terminal system on the terminal server. It gives a lot of advantages, both in respect of initial deployment of workplaces (there is no need to set the software on each terminal), more convenient carrying out of the data backup (it is necessary to copy only the server content), restoration of sessions after failures (all the users' sessions remain automatically on the server).

The system, network, special software (the license software like LabVIEW, SCADA Winn CC, EXCEL, MatLab, MATCAD, STEP 7 and any software for the ODE) is set on the server and is available for workplaces and client computers by the channels of the local and global network.

There are differentiated the processes and events of such attributes as storage, network, technologies of virtualization, monitoring and controlling means between the server, workstations and client computers.

5. Basic provisions for developing the generalized model of distributed objects of monitoring (DOM)

The common features which are available for monitoring subobjects (see above) permit to carry out the development of the generalized model of the distributed subobject of monitoring (OM).

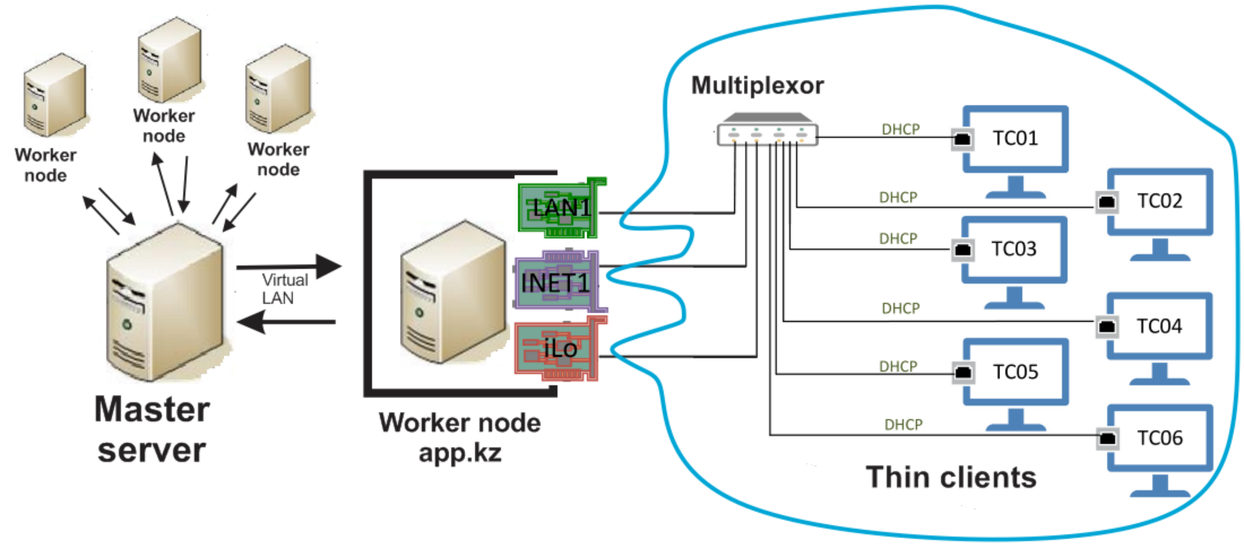

Figure 2. Architecture of the table simulator for DS monitoring

There are proposed the following principles of OM developing:

• the network structure of an object of monitoring is represented by the directed graph and its matrix analogs displaying the graph nodes and bonds;

• there are sources of the initial "product" (there can be several) and receivers of the "product" that in the total relation can differ in properties and characteristics from the initial "products" in connection with the existence of additive and multiplicative hindrances (losses) imposed on the "products" moving by the bonds of the directed graph;

• the dynamic processes happening to the "product" in its movement by the bonds of the directed graph and in the graph nodes move in the network structure of the directed graph with different speeds and are subject to deformations;

• in nodes, as well as in sources and receivers of the moved "products" there is a possibility of assessing (measuring) characteristics of the "products". These characteristics are estimates of additive and/or multiplicative, determined and stochastic (with normal distribution laws) processes;

• the structure and functional capabilities of the table simulator constructed on the basis of the cloud technology eliminate any limits for processes of information storage and mathematical processing of estimates of the “product” characteristics;

• there are options of the hardware, mathematical and program improvement of the quality of estimates of the “product” characteristics;

• there are restrictions of the time and technical monitoring services of the distributed subobjects.

6. Defining the problem of studying the generalized model of monitoring (Conclusion)

From a set of intuitively clear definitions of "Monitoring" we will use one of the formalized sources [7]:

"Monitoring is a complex system of continuous observing the condition of technical devices for controlling, forecasting failures and implementing the requirements of industrial safety of operation by the technical condition",

it follows that studying the MO table simulator, that is an analog of the concrete distributed subobject, it is necessary to define its technical condition in the specific conditions set by the MO parameters until losing the working capacity.

The needed for solving the defined problem of monitoring missing conditions are reduced to determining the criteria of the subobject operability and are not considered in the present article.

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