Formalization of the computational process in a local area network node using informative coloring of user resource requests

O. M. Demidenko, V. N. Kulinchenko, Y. M. Nikitjuk, A. I. Kucharau, D. S. Sych
Francisk Skorina Gomel State University, Gomel, Belarus,
demidenko@gsu.by

***Abstract**. This article describes formalization of the computational process in a local area network node by using complex structure transaction, in the "body" which there are information-colored structure of the workload.*

I. Introduction

When compiling the formal description of the system, the investigator is recommended to perform the following sequence of actions: clarification of the system decomposition; algorithmization of the model components; information coupling of the model algorithms; establishment of control links between the model components; clarification of interaction with the control program of the simulation; documentation of the stage.

This article considers development of the simulation model of the computational process of the local area network (LAN) node for the case, when the simulation model is used to adapt the workload to the resource composition of the LAN node.

Formalization of the computational process of the LAN node by using complex structure transactions, the "body" of which contains the information-colored structure of the workload on the LAN node, is suggested.

II. Formalization of the workload for adaptation to the existing resource composition of the LAN node

If the study subject is a computing process on the local area network node, which is a server, then the dynamics of the resource usage by user requests is difficult to represent using the semi-Markov model. [1]

Therefore, let's represent the flow of user requests for resources F to the LAN server in the dialog (DR) and the distant (DIS) modes using the corresponding time diagrams (TD DR_j and TD DIS_j) of the processor (CPUj) and the memory (HDD_j) use.

The following parameters of simulation of DR and DIS modes are determined using time diagrams:

time of servicing of the k^{th} user requests by the server (τ_{Djk});

intervals of CPU_{Lj} and HDD_{Lj} use respectively (Δt_{11jk} and Dt_{12jk}) during the k^{th} request servicing cycle of the DR mode;

number of uses of $CPU_{1j}(n_{11j})$ and HDD1j(n_{12j}) in the DR mode;

intensity of requests from DIS(Tj) mode users to the server;

intervals of CPU_{2j} and HDD_{2j} use respectively (Δt_{21jk} and Dt_{22jjk}) during the request services of the DIS mode;

number of $CPU_{2j}(n_{21j})$ and $HDD_{22}(n_{22j})$ uses in the DIS mode.

The time intervals and the number of CPU_j and HDD_j uses, as well as the duration of the server use cycle in the DR and DIS modes (Δt_{11jk} and Dt_{12jk}) are random values. Therefore, the dynamics of the LAN server resource use are respresented as follows:

$F_{11j}(\Delta t)$ – F_{12j}(Dt) –distribution functions of use duration of CPUj and HDDj respectively in the DR mode;

$F_{21j}(\Delta t)$ – F_{22j}(Dt) –distribution functions of use duration of CPU_j and HDD_j use respectively in the DIS mode;

$\bar{\tau}_{Dj}$ – mean value of the user interaction cycle in the dialog mode;

$\lambda_{1j} = 1/\bar{\tau}_{Dj}$ – intensity of incoming dialog requests from users (resource requests are assumed to arrive at equal intervals) in the DR mode;

$p_{Dj} = \dfrac{n_{12j}}{n_{11j}}$ – probability of HDD_j use in the interaction cycle of users' dialog requests;

$\bar{\tau}_{Tj}$ – mean value of the execution cycle of transit requests;

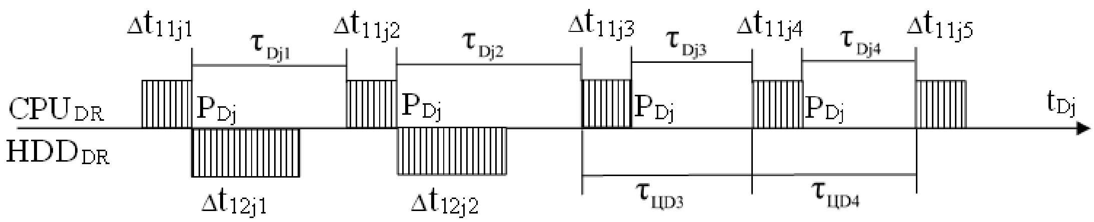
$\lambda_{2j} = 1/\bar{\tau}_{Tj}$ – intensity of incoming transactional requests from users in the DIS mode;

$p_{Tj} = \dfrac{n_{22j}}{n_{21j}}$ – probability of HDD_j use in the interaction cycle of the user's transactional request.

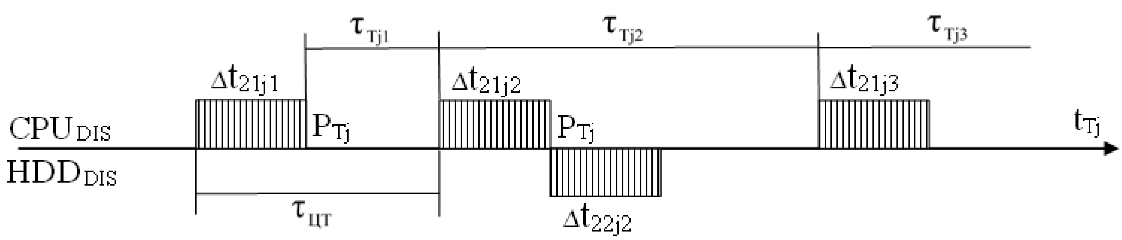
III. Creation of basic structures

The second part of the workload on the LAN node is the sequence of "bodies" TR_{Fj} . The formal description of the composition of the LAN node resources consists of the algorithms for the functioning of three processes simulating the use of LAN node resources.

a) DR mode



b) DIS mode



c) FON mode

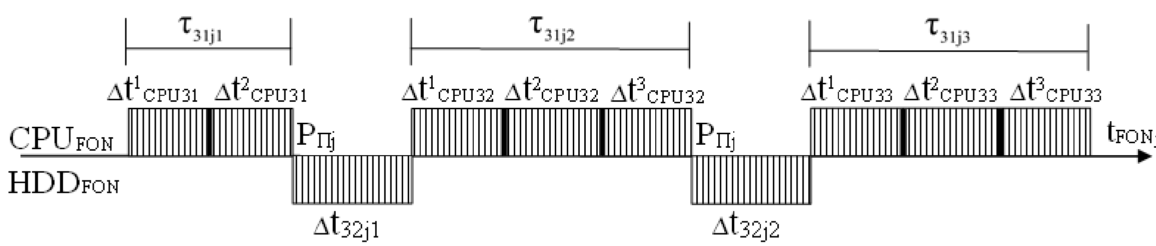


Fig.1. Time diagram of use invariants CPU*j* and HDD*j* of the j^{th} LAN node in three modes of use of requests for LAN node resources (excluding interruptions of CPU and functioning of the LAN node operating system)

The first type of simulators employs the following function algorithm. Generators ($GEND_k$ and $GENT_k$) with intensities λ_{Dj} and λ_{ij} generate, respectively, the transactions TR_{Dj} and TR_{Tj}, recording the moments of appearance of transactions (t_{PDj} and t_{PTj}). Once servicing by CPU_j of the previous transaction with respect to probabilities P_{Dj} and P_{Tj} is completed, the transactions λ_{TRj} and TR_{Tj} return to the generators.

Upon completion of transaction servicing by the HDD_j device, the previous transactions return to the generators $GEND_k$ and $GENT_k$, where they are erased. At the moment of transaction erasure, the statistics of the transaction servicing interval by the LAN node is recorded, respectively ($t_{ExchCDjk}$ and $t_{ExchCTjk}$).

The second type of simulators employs the following CPU_j function algorithm. Transactions from the queues to CPU_j are processed according to the priority of such queues in the following sequence: TR_{Dj}, TR_{Tj} and TR_{Fj}. Once the transaction is selected from the queue to CPU_j, the transaction is serviced for Δt_{oc}. Upon expiration of this time interval, a check for presence of higher-priority transactions in the queues is performed.

If there are higher-priority transactions, PR_{Tj} returns to the beginning of the queue (QUE_1), and TR_{Fj} goes to the beginning of the queue (QUE_3). As for the external device CPU_j for probabilities PD_j, PT_j, PF_j, transactions TRD_j, TRT_j, TRF_j go to queues QUE_4, QUE_5, QUE_6, respectively, to the device HDD_j.

The third type of simulators has the following function algorithm of the process simulator HDD_j: transactions TRD_j, TRT_j and TRT_j are selected from the queues to HDD_j (according to the priorities of these queues). Once the transaction is selected from the queue to HDD_j simulation of transaction servicing for Δt_{oc} is performed. It shall be noted, that unlike with the simulator of CPU_j, transactions TK_j, TR_{Tj} and TR_P are serviced with no interruption of HDD_j. Once servicing of quantum number Δt_{oc} (n_{12} and n_{22}) on HDD_j is over, transactions TR_{Dj} and TR_{Tj} return respectively to $GEND_k$ and $GENT_k$.

At the moments of completion of servicing of TRF_j, the number of serviced "bodies" is modified ($\Omega sj = \Omega sj - 1$) and a check, whether the last element of task S has been serviced (the end of the task) or not, is performed. When the last quantum of CPU_j and HDD_j device use is executed, selection of the next task from the pack is initiated. In this case, the condition for ending the simulation of the entire task pack is checked [2].

IV. Conclusion

The result of the work is the formal description of the complex system, free from the secondary information (available in the informal description) and establishing the structure of the algorithmic representation of the modeling object.

It may turn out that the information available in the informal description is insufficient for formalizing the modeling object. In this case, it is necessary to return to the stage of compiling the informal description and supplement it with data, the need for which is discovered during the formalization of the modeling objects. In practice, there may be several such returns. [3]

The article shows examples of formalization of the computational process in a local area network node by using complex structure transactions, the "body" of which contains the information-colored structure of the workload.

References

[1] *Demidenko, O.M.,* Tools and technique of monitoring resource distribution for design simulation of organization of information processing, *Journal of automation, mobile robotics & intelligent systems,* Volume 3, № 4, 2009, pp. 118-120.

[2] *Demidenko, O.M., Kucherov A.I.,* Comparative analysis of mathematical methods to improve the reliability of the information and technical systems, *Scientific and technical journal «Problems of physics, mathematics and technics»,* Volume 22, № 1, 2015, pp. 92-97.

[3] *Khobnya, A.I., Liauchuk, V.D., Demidenko, O.M.* Conceptual model of mechanisms for ensuring quality of service in packet-switched networks // *Scientific journal «Informatics»,* №2, 2016, pp.78-87.