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NETWORK FEATURES STUDY OF THE COMMUNICATION INTERFACE OF MULTIPROCESSOR MODULAR SYSTEMS

This paper considers so-called "blade" server solutions of multiprocessor systems with several of the same type of maternal modules installed in a single case. It is shown that the computations parallelisms effectiveness of such systems significantly depends on many factors; one of the most essential is the data features between the neighboring nodes of the multiprocessor system, which is usually the slowest part of the algorithm and can negate the effect of the number of used processors. The network interface channel aggregation can solve the indicated problem.

The studies show that, at present, the channel aggregation problem in modular multiprocessor cluster systems has not been solved properly. Meantime, there are critically few studies that reveal the architectural influence of the multiprocessor system network interface on computing performance.

The work set the goal to improve the network interface structure of the multiprocessor system and increase its performance by multidimensional network interface channels aggregation, adapted to solving the studied class problems. At the same time, the network interfaces main operating modes in multiprocessor computing systems were analyzed, their impact on the assessment of the parallelization performance was revealed, and ways to increase the multiprocessor system efficiency by its network interface architecture reorganization.

An analysis of the detected modes of network interface operating in the modular multiprocessor cluster system was run. For the first time, analytical ratios of the multiprocessor computing system efficiency were derived from its network interface parameters. The operation conditions of the cut-through switch are determined so that the information is transmitted without the store-and-forward switching procedure. That approach ensures the transmission of the package at the highest speed, which leads to improving the multi-processing system efficiency in the organization of multi-channel modes of its network interface operation.

The practical value of the results obtained is the proposed multiprocessor system application to create new technological processes. Separately, the application relevance of the proposed approach to solve the digital economy problems should be noted.

Keywords: multiprocessor systems, network interface, aggregation, computing nodes, acceleration of computations.

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ДОСЛІДЖЕННЯ МЕРЕЖЕВИХ ХАРАКТЕРИСТИК КОМУНІКАЦІЙНОГО ІНТЕРФЕЙСУ БАГАТОПРОЦЕСОРНИХ МОДУЛЬНИХ СИСТЕМ

Статтю присвячено дослідженню так званих "блейд" серверних рішень багатопроцесорних обчислювальних систем, відповідно до яких декілька однотипних материнських модулів встановлюються в одному корпусі. Показано, що ефективність розпаралелювання обчислень таких систем істотно залежить від багатьох чинників. Проте, один з найважливіших - це особливості пересилки даних між сусідніми вузлами багатопроцесорної системи, яка зазвичай є найповільнішою частиною алгоритму. У зв'язку з цим підкреслюється, що важливим чинником підвищення ефективності функціонування модульних багатопроцесорних систем є проблема вибору, конструювання і організації їх мережевих інтерфейсів.

Відзначається, що вказану проблему можна розв'язати за рахунок агрегації каналів мережевого інтерфейсу. Проте нині проблема агрегації каналів в модульних багатопроцесорних кластерних системах не розв'язана належним чином. З іншого боку, критично мало досліджень, в яких розкривався би вплив архітектури мережевого інтерфейсу багатопроцесорної системи на ефективність розпаралелювання обчислень.

У роботі поставлена мета удосконалення структури мережевого інтерфейсу багатопроцесорної системи та підвищення її продуктивності за рахунок багатовимірної агрегації каналів мережевого інтерфейсу, адаптованого до розв'язування задач досліджуваного класу. При цьому проведено аналіз основних режимів роботи мережевого інтерфейсу у багатопроцесорних обчислювальних системах і виявлено їх вплив на оцінки ефективності розпаралелювання, а також показано шляхи підвищення ефективності багатопроцесорної системи за рахунок реорганізації архітектури її мережевого інтерфейсу.

Уперше виведені аналітичні співвідношення оцінок ефективності багатопроцесорної обчислювальної системи через параметри її мережевого інтерфейсу. Проведений аналіз виявлених режимів роботи мережевого інтерфейсу в модульній багатопроцесорній кластерній системі. Визначені умови роботи комутаційної матриці комутатора в режимі наскрізної комутації (cut - through) з тим, щоб інформація передавалася без використання процедури буферизації. Такий підхід забезпечує передачу пакетів з найбільшою швидкістю, що призводить до поліпшення оцінок ефективності багатопроцесорної системи при організації багатоканальних режимів функціонування її мережевого інтерфейсу.

Практична цінність отриманих результатів полягає в застосуванні запропонованої багатопроцесорної системи для створення нових технологічних процесів. Окремо слід зазначити актуальність застосування запропонованого підходу для розв'язування задач цифрової економіки.

Ключові слова: багатопроцесорні системи, мережевий інтерфейс, агрегація, обчислювальні вузли, прискорення обчислень.

Introduction

The parallel computing systems application is caused by the fundamental restriction of the maximum possible performance of ordinary sequential computers. However, it is explained by the almost constant computing tasks, for which the possibilities of available computer equipment are insufficient.

This paper considers so-called "blade" server solutions of multiprocessor systems, where several maternal modules are installed in single cases [1, 2]. Practice shows that blade systems are more compact and convenient to maintain, and their implementation is not much more expensive than multiprocessor computing structures. Nevertheless, thanks to the growing demand and offer of "blade" configurations in our market, this kind of cluster computing system was designed. The main features of its architectural design are set out in [3, 4]. In the cluster configuration, its implementation modular principle was chosen. That provides, if necessary, its expansion by installing additional modules. Each node works under the control of its copy of the operating system. The composition and power of such a cluster's nodes can change, allowing the creation of heterogeneous systems. The switching network connects the system's computing nodes. The system contains a separate reconfigured network to interchange data between computing nodes, additional controlled switches that work in parallel, intermediate buffers of the switch, and provides for network loading of nodes and a reservation mechanism of key components.

Almost simultaneously with the first multiprocessor systems advent, it was necessary to assess their effectiveness, performance, and speed and subsequently compare such computing systems, considering those parameters. However, the parallelization performance of computations significantly depends on many factors; one of the most important is the data features between the neighboring nodes of the multiprocessor system, which is usually the slowest part of the algorithm and may negate the increased effect in the number of used processors. Those issues were determined for the modeling procedure for a wide class of tasks by modular multiprocessor cluster systems and were developed in [5 - 8].

However, there is no proper development, or there are no papers devoted to studying the network interface's influence on the modular multiprocessor computing systems' performance. Consequently, the important factor in the modular multiprocessor systems' performance is their network interfaces' selection, design, and organization. The multiprocessor cluster system performance studied in this paper will be evaluated from those positions.

Setting the research problem and its relevance

One of the main problems of the modular multiprocessor cluster systems application can be formulated as follows: we have a variety mesh of M dimensions, and the t value determines the problem computation time that is solved by a single processor system. That parameter is critical. It is necessary to reduce the computation time, maintaining the M value significantly. Hence, the issues of effectiveness, speed, and performance are the main attention when constructing cluster systems. That approach is focused, e.g., on developing new technological processes (when the computation time is a critical value) [9, 10]. In addition, similar problems often must be solved in medicine, military equipment, etc. At the same time, the parallelization effectiveness of computations depends on many factors; however, the network interface organization is one of the defining. Currently, such a problem has not received proper development for modular multiprocessor cluster systems. In this regard, the studies considered in this paper are paramount and will undoubtedly cause interest among relevant specialists.

Analysis of recent studies and publications

So, the task is considered to reduce the computation time by increasing the number of components of the cluster system. Meanwhile, we will assume that the computation area is evenly distributed between the nodes of the cluster system. For the research convenience, we will assume that the area form on which the computations are run is square.

A complete and comprehensive analysis of assessments of the effectiveness of the modular multiprocessor cluster system is given in [11, 12].

However at planning and effective use of the multiprocessor system basic attention is spared to the interconnect network of the system and her topology [13]. Topology of cluster and his fast-acting at the decision of calculable tasks, undoubtedly, problems are constrained.

To our opinion, the new high-quality stage of development of the multiprocessor cluster systems lies in area of the use of new modern network technologies [14]. Thus efficiency of parallelization of calculations depends on many factors, however one of qualificatory are a choice and organization of network interface. It is explained as follows. The network of the cluster computer system fundamentally differs from the network of the work stations, although for the construction of cluster ordinary network maps and switchboards which are used during organization of network of the work stations are needed. However in case of the cluster computer system there is one fundamental feature. The network of cluster, first of all, is intended not for connection of computers, and for connection of calculable processes. In this connection, than higher there will be a carrying capacity of computer network of cluster, the user parallel tasks, executable on a cluster, will be considered quicker. Thus, technical descriptions of computer network acquire a primary value for the multiprocessor cluster systems.

Note that during multiprocessor systems, processors interchange data at the joints of computing areas during each iteration, using variables' current values. In this respect, the data transfer features between neighboring nodes of the multiprocessor computing system were considered in the above works. The options for one-sided and bilateral data transfer between processors were compared in this case. As expected, with bilateral data interchange mode, the computation acceleration decreased by increasing the boundary data exchange time.

To study the ways to accelerate computations, the method influence of transmitting data between the cluster system nodes was separately studied. In this regard, the influence of the duplex and semi-duplex mode of data transmission in the computing network was investigated. Note that the duplex mode is the speediest computing system. It allows for effective use of the computational capabilities of cluster structures in combination with high data transfer speed channels. Given the described circumstances, the indicated works emphasize the importance of studying the multiprocessor system performance features in implementing the duplex operation mode. So, the review shows that, on the one hand, quite serious attention is paid to issues of studying the multiprocessor cluster systems performance.

The studies conducted in this paper aim to eliminate the specified deficiency when analyzing the multiprocessor cluster systems' performance. On the other hand, such studies cover the most diverse modes of functioning cluster multiprocessor systems. However, it can be noted that today the influence problem of the cluster system network interface on its effectiveness is not fully disclosed. Moreover, the research on improving the network interface architecture was also not developed to increase the data interchange rate between the computing nodes of the multiprocessor cluster system.

The research's purpose and objectives

The main goal of the studies is to develop further the approach related to the performance assessments analysis of the multiprocessor cluster modular computing system. Meantime, the main focus on the network interface influences the features of such a system in assessing its effectiveness.

As a result of the studies, the following tasks must be solved:

- identify and establish the main modes of network interface operation in multiprocessor cluster systems;
- analyze the main modes of network interface operation in multiprocessor cluster systems and identify their impact on the parallelization performance assessment;
- identify ways to increase the multiprocessor cluster system efficiency by organizing its network interface architecture;
- for determining assessments convenience of the multiprocessor computing system performance, to derive the main analytical ratios via network interface system parameters.

Purpose of the research's main material

In the first stage of research, we consider the formation features of the network interface architecture of the cluster system and the main modes of its operation, and then, in the second stage, we will analyze the cluster system processors' interaction with its interface.

So, to evaluate the processes occurring in the cluster system when organizing the relevant information flows, it is necessary to compare the cluster network throughput and the switch throughput. That procedure is necessary for the optimal components' selection of the multiprocessor system network interface. Therefore, for the research convenience, we will introduce into consideration a parameter such as an interface overall throughput of the multiprocessor system according to the manufacturer's specification (V_i):

$$V_i = V_p \cdot N. \tag{1}$$

Here N is the number of cluster nodes and V_p is the protocol throughput of the modular system interface, Gbit/s. For the exhausted multiprocessor system, the interface speed corresponds to 200 Gb/s.

When designing a multiprocessor computing system, the *NVIDIA* hardware was used. In the considered multiprocessor system, the *NVIDIA QUANTUM-2* switch is used. Each of the eight ports in this system can simultaneously transmit and accept data at full speed of 400 Gb/s in the duplex mode. In that case, the capacity is specified in packages per second, and the declared 1600 Gb/s are achieved when transmitting large packages. We assume that the mesh considered by the mesh boundaries has just such features. With that approach, one can compare the total interface throughput of the modular multiprocessor system (V_i) and the switch capacity (V_k).

For further analysis of the cluster system network interface, we put the coefficient k_s into consideration, and we will interpret it as a throughput coefficient of the multiprocessor system interface that we determine as:

$$k_s = \frac{V_i}{V_k}. \tag{2}$$

Considering equation (1), we get:

$$k_s = \frac{V_p \cdot N}{V_k}. \tag{3}$$

In [12], studies are true for the so-called "ideal" cluster when k_S=1, i.e., all the necessary information for transmissions in the cluster system via the switch is distributed without delay between its necessary nodes. Such a campaign for the processes study in cluster systems was useful to identify the main operating modes of the cluster system and evaluate them respectively. However, it is almost impossible to create an 'ideal' cluster in practice. Hence, the previously revealed features of the cluster system functioning must be clarified considering new circumstances that have been revealed. For this approach development, we considered the coefficient concept of switch throughput capacity (k_k):

$$k_k = \frac{V_k}{V_p \cdot N}. \tag{4}$$

For a more detailed analysis of the multiprocessor system operation, we consider some features of its switch operation. So, if *N* nodes of the multiprocessor system try to establish a connection with one knot on the *InfiniBand* protocol [13, 14], the switch's cross bus can allocate only a bandwidth strip for each node (c_k) that is determined based on the ratio of the type:

$$c_k = \frac{V_k}{N}. \tag{5}$$

In such circumstances, we will perform the procedure for modeling those coefficients depending on the number of cluster system nodes.

Table 1 lists the initial data for studying the changes area in the multiprocessor system network interface coefficients.

Table 1

The initial data for computing the cluster system network features

V_K	200 Gbit/s
V_k	1600 Gbit/s

Table 2 represents the resulting modeling results.

Table 2

The modeling results

Quantity of nodes, N	k_s	k_k	c_k
2	0,25	4,00	800,00
3	0,38	2,67	533,33
4	0,50	2,00	400,00
5	0,63	1,60	320,00
6	0,75	1,33	266,67
7	0,88	1,14	228,57
8	1,00	1,00	200,00
9	1,13	0,89	177,78
10	1,25	0,80	160,00
11	1,38	0,73	145,45
12	1,50	0,67	133,33
13	1,63	0,62	123,08
14	1,75	0,57	114,29
15	1,88	0,53	106,67

The modeling results are also presented as graphic dependencies (Fig. 1). For the analysis convenience of the studied coefficients, the corresponding graphic dependencies are presented in a single coordinate system.

We will conduct the results' preliminary analysis. Obviously, with an increase in the number of nodes of the multiprocessor system, the network capacity will increase (V_i). The change in the bandwidth of the system interface (k_S, Equation 3) will be run according to linear law (Fig. 1, line 1). On the other hand, the growth of the data volume transmitted between the system module units will lead to the switch overloading it, and its bandwidth coefficient (k_k, Equation 4) will decrease according to the non-linear law (Fig. 1, line 2).

So, a preliminary results analysis of modeling the main network coefficients of the multiprocessor system created the prerequisites for summarizing the results. Then, for a complete research picture, we introduce some definitions, and then, considering the formulated definitions, we conduct a detailed analysis of the main network features of the system.

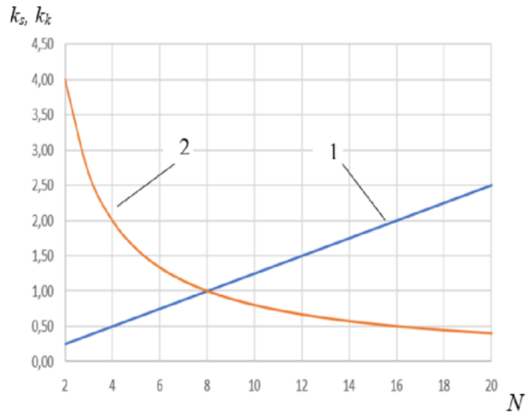

Fig. 1. Dependence of the main network coefficients of the multiprocessor system on the number of nodes

Definition 1. *A network equilibrium point* is a point at which the bandwidth values of the multiprocessor system interface and the switch throughput coefficient will be equal.

Definition 2. *The equilibrium number of multiprocessor system components* is the number of nodes that corresponds to the network equilibrium point.

Definition 3. *An ideal multiprocessor modular system* is a system where the equality of the following network features is fair $k_s = k_k$.

Definition 4. *A real multiprocessor modular system* is a system, where the following inequality for network features is observed $k_s \neq k_k$.

Definition 5. *The resource deficiency of the multiprocessor system network interface* is such a case of the system functioning where the inequality of the following network system features is performed $k_s < k_k$.

Definition 6. *Excessive resources mode of the multiprocessor system network interface* is such a case of the system functioning where the inequality of the following network system features is performed $k_s > k_k$.

So, considering the above definitions, it is possible to clarify the network interface functioning features of the modular multiprocessor system and perform a detailed analysis of the main computation ratios, given in table 2.

As part of the analysis of the multiprocessor system network interface at the first stage, we note some necessary features of the switch functioning. Meanwhile, we note that the switch performance depends significantly on the switching types. The switch used supports four switching types:

– *cut-through*;
– *store-and-forward switching*;
– fragment-free switching;
– *intelligent switching*.

With the cut-through switch, only a few of the first bytes of the package are received in the input port buffer, which is necessary to read the destination address. After setting the destination, in parallel with the reception of the remaining bytes of the frame, the required route switches, and the package is transmitted to the output port if other cluster devices do not use it. Otherwise, the entire package enters the buffer of the entrance port. The cut-through switch provides the highest switching speed and a significant performance gain.

With store-and-forward switching, the package enters the entrance port buffer, whereby the control amount is checked for errors. The package is transmitted to the output port if the errors are not found. That switching method guarantees filtration from erroneous packages; however, the switch capacity is reduced due to the store-and-forward switching procedure.

With fragment-free switching, not the entire package enters the input port, but only the first 64 bytes. For a minimum packet, this corresponds to the full store-and-forward switching, and for packages whose size is more than 64 bytes, that corresponds to a cut-through switch. Thus, with non-fragment switching, only minimal personnel are to be checked.

The switcher chooses the optimal operating mode for each port with intelligent switching.

We first note that to obtain high-performance assessments and accelerate the multiprocessor system computations, it must function in one of the indicated switching types in *network interface resource deficiency mode*. Such a statement is obvious because the total speed of the transmitted and accepted data by all nodes of the multiprocessor cluster system should not exceed the switch throughput.

The main features of *such a modular multiprocessor system (including speed) will deteriorate significantly, and the main task of forming a computation multiprocessor will lose its meaning. The main feature of the network* *interface's excessive resources mode* is that the switch may get overloaded when the incoming traffic exceeds the output. In this case, the data switching conditions change. Here, the switch goes into the store-and-forward switching mode, which leads to a loss of switch performance. However, a critical increase in the data volume in the port leads to its overflow and, as a result, to information loss. Hence, the switch will not be able to provide the most stable and reliable formation of the data switches in the computing system.

In general, we note that the results of modeling the multiprocessor system's main network features show that *network interface resource deficiency mode* is characteristic of low-performance multiprocessor systems, in which network interface can be built on primitive switches or with its unsuccessful organization.

Finally, modeling the system's main network feature convincingly refutes the statement "the more nodes in the cluster system, the faster it operates."

Next, we proceed to a more detailed analysis of modeling the system's main network features considering the noted circumstances. Obviously, in considering network interface parameters, the "ideal" multiprocessor system will be when its number of nodes corresponds to $N = 8$ (Table 2). In addition, Table 2 shows the switching lane computation of the switch (c_k) for this network interface operation mode. Note that the value $N = 8$ of the passage strip for each output port of the cluster system will correspond to 200 Gb/s, which is fully consistent with both the duplex mode of data interchange in the multiprocessor system and with the system capabilities. Hence, the multiprocessor system network interface will function in its *resources deficiency mode of multiprocessor system network interface* and maximum allowable loading conditions of the switching channels. Thus, the declared switch technical capabilities will be fully consistent with the switching network capabilities.

Considering the marked circumstances, there are prerequisites for general analysis of the network interface of the multiprocessor system functioning. To do this, we introduce such a feature as the modular system coefficient capacity (k_p):

$$k_p = \begin{cases} 1, \text{for the mode of network interface resources lacking,} \\ k_k, \text{for the mode of network interface resources excess.} \end{cases} \quad (6)$$

Fig. 2 shows a geometric interpretation of the change in the modular system capacity coefficient from the number of its lines. Furthermore, the analysis of this dependence shows that it is obvious for the network interface resources deficiency that the network interface features will determine the multiprocessor system's bandwidth coefficient. Meanwhile, due to the network interface resources deficiency features, such a coefficient is taken equal to unity since the switching matrix will work in a cut-through switch, and the information will get transmitted at the highest speed without the store-and-forward switching of transmitted packages. In the network interface excess resources mode, such a parameter will be determined by the switch's features when incoming traffic exceeds the output. Here, the switch goes into the store-and-forward switching mode leading to its performance loss. Figure 2 reflects that circumstance in the waning line.

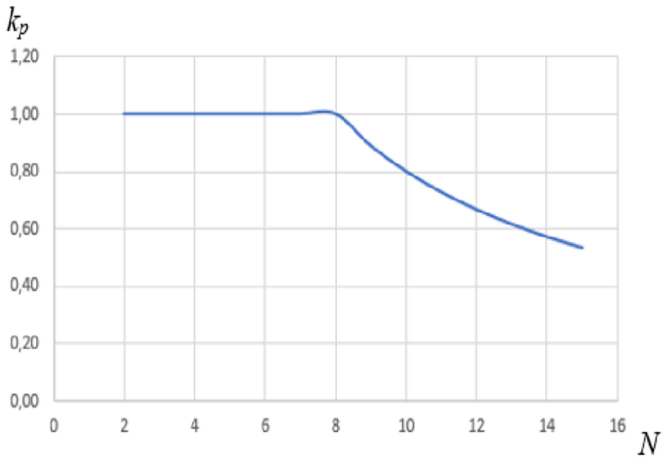

Fig. 2. Dependence of the coefficient of throughput of the multiprocessor system on the number of nodes

Analysis of the identified functioning modes of the multiprocessor system network interface allows formulating the following problem: how can one increase the estimates of the multiprocessor systems' network interface? In other words, this problem can be formulated differently: *How can one increase its performance and speed assessments by the architecture design features of multiprocessor modular systems' computing networks?*

Such a problem can be solved as follows. The main feature of the studied multiprocessor cluster system is that the data interchange between computing nodes is submitted to a separate network operating on the channel (second) level using *channel bonding* technology [3]. That approach aims to increase the data interchange rate between the cluster nodes and decrease the channel load that connects the cluster nodes. On the other hand, the *Socket Direct* technology of the multiprocessor system interface throughput.

Furthermore, the network interface channels aggregation by introducing additional controlled switches that work in parallel, allowing to change the network configuration via the terminal or WEB interface, and increasing its throughput [13]. Such a network architecture provided high-speed access to the nodes' memory. In general, we note that the reconfigured network implementation increases the multiprocessor system performance, adapting its network structure to solve each specific type of task.

So, the proposed network multiprocessor system architecture will allow, firstly, to increase the computation speed when solving highly tied tasks and, secondly, to provide high-speed access to the memory of the cluster components, reducing the channel loading, which occurs between the computing system nodes. In this respect, further efforts will be aimed at obtaining the numerical assessments of the cluster system network interface by the *channel bonding* technology implementation and the channels aggregation of the system's network interface. For that purpose, considering the *channel bonding* technology and the network interface aggregation procedures must be clarified by ratios (3) and (4), which characterize the main network features of the cluster system. The system's network interface bandwidth will determine in the following way:

$$k_s = \frac{V_p \cdot N \cdot k}{V_k \cdot k_m}. \tag{7}$$

Here k is the number of symmetric computing subnets that operate simultaneously due to *channel bonding* technology, k_m is the number of switching matrices in the data interchange network.

Switch capacity (k_k) remains the same:

$$k_k = \frac{V_k \cdot k_m}{V_p \cdot N \cdot k}. \tag{8}$$

Table 3 lists the initial data for studying the operating mode of the multiprocessor system network interface.

Table 3

The initial data for network features computations of the multiprocessor system by the network interface channels aggregation mode

V_p	200 Gbit/s
V_k	1600 Gbit/s
k	4
k_m	2

Table 4 presents the modeling results.

Table 4

The results of computing the main network coefficients of the multiprocessor system by the network interface channels aggregation mode

Number of nodes, N	k_s	k_k	c_k
2	0,50	2,00	3200,00
3	0,75	1,33	2133,33
4	1,00	1,00	1600,00
5	1,25	0,80	1280,00
6	1,50	0,67	1066,67
7	1,75	0,57	914,29
8	2,00	0,50	800,00
9	2,25	0,44	711,11
10	2,50	0,40	640,00
11	2,75	0,36	581,82
12	3,00	0,33	533,33
13	3,25	0,31	492,31
14	3,50	0,29	457,14
15	3,75	0,27	426,67

The modeling results are also presented as graphic dependencies (Fig. 3).

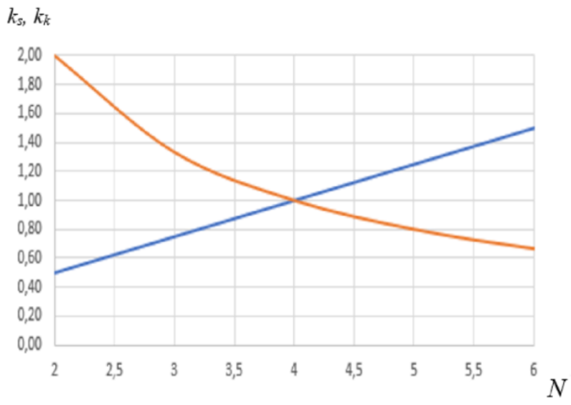

Fig. 3. Dependencies in the main network coefficients of the multiprocessor system on the number of nodes in the network interface channels aggregation mode

So, there were prerequisites for a general results analysis. It is obvious that the presented mode of operation, under equalized other conditions, due to changes in the architecture of the network interface of the multiprocessor system, will not only expand the passing strip of the switch's cross bus but also significantly reduce the number of multiprocessor system components for its functioning in the network interface optimal version. The latter circumstance means that the formed operating mode of the multiprocessor system network interface provides wider opportunities for the necessary computations, significantly improving the efficiency and performance features.

Theoretical computations are fully consistent with the results of numerical modeling of the main features of the cluster multiprocessor system's performance. A comparative analysis of the computation results without reorganizing the network interface architecture (Table 1) and after the network interface channels aggregation (Table 2) illustrated that increasing the data interchange rate between the computing system nodes reduced the channels' loading that connects those nodes. That approach allowed significant growth in the multiprocessor system performance assessments.

Conclusions

The paper demonstrates ways to increase the multiprocessor modular system performance by reorganizing its network interface architecture. The proposed approach allowed not only increased the parallelization efficiency but also significantly reduced the computation time. Such results were achieved by reducing the boundary data interchange time between the cluster system's computing nodes.

Wherein:

1. The two main network interface modes operating in the modular multiprocessor cluster system were identified. The formation conditions for the equilibrium number of computing nodes of the multiprocessor cluster system are shown when the network interface resources lack mode goes into its excess mode.

2. The analysis of the identified operating modes in the modular multiprocessor cluster system network interface was run. It is shown that to obtain high assessments of computations' performance and acceleration in the multiprocessor system, it must operate in the network interface resources lack mode. It was revealed that the main feature of network interface resource excess is that the switch gets overloaded when incoming traffic exceeds the output. Moreover, the main performance features of such a cluster system will deteriorate significantly.

3. The switching matrix working conditions are determined in the *cut-through* mode to transmit the information without the store-and-forward switching procedure. This approach provides the transfer of packages with the highest speed, which improves the multiprocessor system performance when organizing multi-channel modes of its network interface operation.

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